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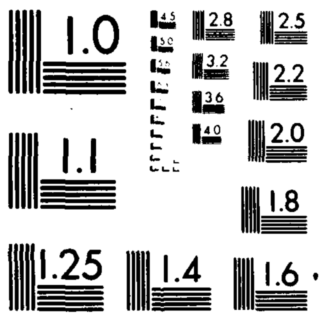

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NATIONAL AVIATION FUEL SCENARIO ANALYSIS PROGRAM (NAFSAP)

LEVEL II

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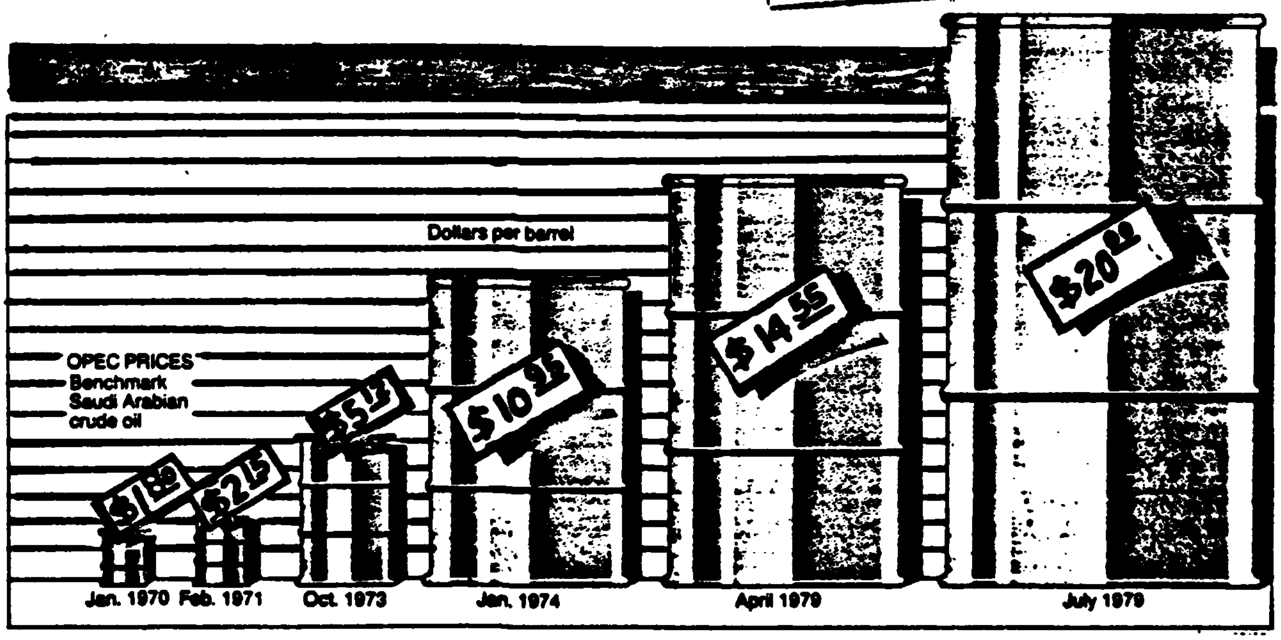
VOLUME I: MODEL DESCRIPTION

VOLUME II: USER MANUAL

BY

STEVE VAHOVICH



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16. Abstract

This report forecasts air carrier jet fuel usage by body type for three user defined markets. The model contains options which allow the user to easily change the composition of the future fleet so that fuel usage scenarics can be "run." Both Volumes I and II are contained in this report. Volume I describes the structure of the model. Volume II is a computer users mannual.

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NATIONAL AVIATION FUEL SCENARIO ANALYSIS PROGRAM
(NAFSAP)

VOLUME I: MODEL DESCRIPTION

BY

STEVE VAHOVICH, AEE-200

SEPTEMBER 1979

I. INTRODUCTION

NAFSAP is a computer simulation program which forecasts U.S. domestic fleet fuel burned from user supplied scenario inputs. The outputs from NAFSAP are presented using both tables and graphs.

The computer model and data are stored on the Computer Science Corporation (CSC) computers. The procedures to access NAFSAP and execute the computer program are described in "Volume II: USER MANUAL." The computer program is written in Fortran computer language.

NAFSAP is a quick and easy way to conduct scenario analysis, focusing on differences in fuel consumed given alternative user inputs. The user describes the following inputs to the program:*

(1) The market (types of aircraft and their associated typical utilization, seats, speed, load factor, and fuel consumption rates);

(2) The target revenue passenger miles (RPM) for the forecast years; and

(3) Options determining how the program will create and fly aircraft to meet the target PRMs.

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*Default historical data bases and default forecasts RPM data (see User's Manual), utilizing the most recent data, are available to the user.

Variations in any or all of these input parameters form the input scenario. Results, obtained by executing NAFSAP across different input scenarios, may be compared to determine the fuel impact of changes in the input set.

In brief, NAFSAP operates in the following manner. The program cumulates the number of aircraft purchased over the most recent 16 years of history to form the base year fleet (currently, the last historical year is set at 1978). Then it extends the base year fleet to future years retiring each aircraft after say 16 years (user specified option) of service (e.g., an aircraft purchased in 1978 is retired in 1994). This extended base year fleet, net of future retirements, forms the "basic core fleet." NAFSAP then computes the RPMs that are possible when this basic core fleet is flown according to the user specified input parameters (see Item 1, above). It then compares the possible against the target RPMs, and proceeds to create additional aircraft to exactly satisfy the deficit of target over possible RPMs. The selection of aircraft type(s) for new additions to the fleet is a user option. Fuel consumption is computed from the derived fleet and the fuel consumption characteristics of each type of aircraft.

NAFSAP is a product derived from work originally performed at NASA's AMES Research Center in California. The Office of Environment and Energy, Division of Energy (AEE-200), performed significant program and data modifications and provided additional capabilities to the original NASA program to obtain NAFSAP. In addition, NAFSAP has been subjected to a thorough series of debug test runs. Hence, NAFSAP is a fully tested product. Since the program changes are too numerous to discuss, only the additions to the original program are noted in the following:

(1) Graphics capability using the fairly widely available DISSPLA package.

(2) Capability to easily specify the beginning and ending year for the forecast period.

(3) User option to specify any target revenue passenger mile (RPM), by year, for the forecast period. NAFSAP will then compute the required number of aircraft (according to user options set as per Item 4, below) and fuel burned to meet these RPM requirements.

(4) User option to select among serveral pre-programmed future fleet control criterion, or alternatively, options for the user to design his own future fleet to meet the target RPM requirements.

(5) User option to select among alternative preprogrammed data bases, according to the scenario he wishes to analyze. In addition, the user may create his own specialized data input.

II. MODEL DESCRIPTION

A. INPUTS

NAFSAP uses a three markets concept to disaggregate the total U.S. domestic fleet air carrier transportation system. The three markets are the long, short and medium range markets. There is nothing inherent in the computer program that prevents the user from defining these markets in any fashion desired. That is, the definition of each market is determined by the user supplied values for the following parameters:

PARAMETERS	DESCRIPTION
TYPE	Body type of aircraft
YRINTR	Year first introduced
SEATS	Average available seats per available aircraft mile (all revenue service)
SFC	Fuel consumed in lbs per seat-mile
SPEED	Average block-to-block speed (all revenue services; in MPH)
UTILIZ	Average number of airborne hours (all revenue service)
LIFTIM	Nominal retirement age in years for each type of aircraft
PRPM*	Proportion of total RPMs for that market attributable to each aircraft type

*This input is used by NAFSAP only if the user elects to construct his own future fleet (see OPTIONS section below)

In NAFSAP, the above parameters are defined for the base year, i.e., the most recent year of historical data (currently, the base year for the program and all default data sets is 1978). A sample input data list is presented in Table 1. The values presented in Table 1 represent the markets defined as follows:

-- long range market : statute miles greater than or equal to 2500 (SM $\geq$ 2500)

-- short range market : statute miles less than 1500 (SM < 1500)

-- medium range market : statute miles greater than or equal to 1500 and less than or equal to 2499 (1500 $\leq$ SM $\leq$ 2499)

By substituting a different set of values in Table 1, the user can define the three markets at his discretion.* The first row in Table 1 reads: for the long range market, the first four-engine narrow body turbofan (4 ENGNBTF) aircraft was introduced in 1960; in the base year, the typical aircraft of this body type has 150 seats, consumes .153 lbs of fuel per seat-mile, flew 405 MPH, flying 2,759 hours, was retired 16 years from date of purchase (see following paragraph for data of purchase), and its proportional share of total RPMs for that market is .158 (i.e., 15.8%).

*All of the information required to construct, update, or alter Table 1 can be obtained from The Computer Company by contacting Tom Morrison or Rob Durbin. See Appendix A for sample Technical Assistance Request used to obtain such information.

Table 1

SCENARIO: Default Aircraft Specific Options
(LF =.60 all markets each year)

TYPE	YRINTR	SEATS	SFC	SPEED	UTILIZ	LIFTIM	PRPM
LONG RANGE MARKET							
4 ENGNBTF	1960	150	.153	405	2,759	16	.168
4 ENGWBTF	1969	358	.130	456	3,511	16	.630
3 ENGWBTF	1971	246	.127	419	2,950	16	.202
*3 EWB777	1987	210	.134	450	2,486	16	.030
SHORT RANGE MARKET							
4 ENGNBTF	1960	150	.191	405	2,759	16	.087
3 ENGNBTF	1963	118	.184	359	2,752	16	.549
2 ENGNBTF	1965	91	.213	312	2,448	16	.234
3 ENGWBTF	1971	246	.137	419	2,950	16	.115
2 ENGWBTF	1977	240	.126	360	2,752	16	.015
*2 ENB757	1982	150	.147	300	1,987	16	.0
MEDIUM RANGE MARKET							
4 ENGNBTF	1960	150	.153	405	2,759	16	.271
3 ENGNBTF	1963	118	.155	359	2,752	16	.191
4 ENGWBTF	1969	357	.127	456	3,511	16	.136
3 ENGWBTF	1971	246	.124	419	2,950	16	.386
*2 EWB767	1984	200	.121	360	2,920	16	.030

* = New Type Aircraft.

The second major class of inputs to NAFSAP is the current fleet by year of purchase. That is, once the most recent year (base year) of available historical information has been determined, the preceeding 16 years (including the base year) of the number of aircraft purchases, is input.**

Similarly, if the historical data shows that some aircraft are retired prior to the user specified general retirement age (LIFTIM), this information directly follows the aircraft purchase data in the data base. In the following chapter, the vector of aircraft purchases is denoted by NOBUYS, and the aircraft retirements vector is denoted by NORETIR.

The third major class of inputs to NAFSAP is load factor. The load factor is specified once for each market. Within each market, the load factor is specified by year, for the base year and once for each forecast year. The load factor may be different for each market (and year within each market); however, once it is specified for a market, it applies to each aircraft within that market.

The final class of inputs is the target RPM values. U.S. fleet domestic RPMs are specified (in billions) for the base year and once for each forecast year. As will be detailed below, fuel burn and the future fleet size forecasts, generated by NAFSAP, are driven by the user specified target RPMs for forecast years.

**This information is available from The Computer Company by accessing the B-43 schedule information.

III. COMPUTATIONS IN NAFSAP

The procedure described below highlights the key working relationships in NAFSAP. It does not detail all of the data or computation cross-checks, counters, subroutine calls, or intermediate computations performed in the computer program. It does present a consistent beginning to end explanations of how NAFSAP works.

A. Compute representative figures per aircraft type (I) per year (YR) for:

1. Seat-miles as the product of speed, utilization and seats.

   SEATMI (I,YR) = SPEED (I) * UTILIZ (I) * SEATS (I)

2. RPMs as the product of seat-miles and load factor (LF)

   RPM (I,YR) = SEATMI (I,YR) * LF (YR)

3. Fuel burn as the product of seat-miles and lbs. of fuel consumed per seat-mile

   FUELBR (I,YR) = SEATMI (I,YR) * SFC (I)

As a result of these computations representative figures for seat-miles, RPMs, and fuel burn are available for each body type (and within each market) for the base year and the forecast years. Note, at this point these representative figures are identical across all years (YR).

B. Compute the basic core fleet.

1. Compute the base year fleet (1) by aircraft type (I) from the last 16 years (J).

POPUL (I,1) = POPUL (I,1) + NOBUYS (I,J) - NORETIR (I,J)

That is, the net of the number of buys less the number of retirements are accumulated, over the most recent 16 years, to arrive at the current or base year fleet. The current base year is set in the computer program at 1978 and all default data bases are keyed to that base. (The "USER MANUAL" describes the procedure to change the base year in the program and the user must update the data bases accordingly).

2. Establish the basic core fleet for the forecast years (J + 16) for each aircraft type (I). To simplify the exposition, 16 years is used as the useful life of an aircraft. The first step in establishing this future core fleet is to move the number of historical aircraft purchases, by year, to retirement after 16 years useful life.

NORETIR (I, J + 16) = NOBUYS (I,J)

In the next step, the basic core fleet (POPUL) for years J + 1 (the forecast years) is computed, year by year, and updated each year on the basis of each preceeding year's results.

POPUL (I, J + 1) = POPUL (I, J) - NORETIR (I, J + 16)

For example, the 1979 core fleet is the 1978 core fleet less purchases made in 1963 (i.e., retirements in 1979).

C. Compute total RPMs possible across aircraft types (I) for the core fleet for each forecast year (YR).

TOTAL = TOTAL + RPM (I,YR) * POPUL (I,YR)

That is, for each forecast year, the product of representative RPMs and the number of aircraft, by aircraft type, is aggregated across all types of aircraft. This calculation is repeated each forecast year; however, once the result for any given year is obtained, the computation described in section D, below, is performed prior to the TOTAL compute for a subsequent year.

D. For each forecast year, check the user input target RPMs (MARKET) against possible RPMs (TOTAL)

RPMDIF = MARKET - TOTAL

If RPMDIF is greater than zero, additional aircraft are created according to user specified fleet control options (see "FUTURE FLEET CONTROL OPTIONS" chapter below). All options utilize some form of the following computation to determine the number of additional purchases required to satisfy RPMDIF.

NOBUYS (I,YR) = RPMDIF/RPM (I,YR)

That is, the number of new buys by type (I) per year (YR) is determined by the deficit (of target over possible) RPMs for that year divided by the representative RPM figure for that type of aircraft. For example, if RPMDIF = 100 and RPM (1,2) = 5, then 100/5 = 20 aircraft of type 1 are purchased in year 2.

Finally, these new number of aircraft purchases are used to augment and update the core fleet for the forecast years as follows:

POPUL (I,YR) = POPUL (I,YR) + NOBUYS (I,YR)

That is, the sum of the core fleet and new purchases, by aircraft type for each forecast year, forms the future fleet consistent with the target RPMs.

Note that the two immediately preceeding computations update NOBUYS and POPUL for one forecast year at a time. The program then returns to the first computation shown in section B, subpart 2, and the entire procedure is iterated for each subsequent year.

E. Compute the final outputs by using the representative figures per aircraft type (I) per year (YR), and applying them to the updated fleet which satisfies the target RPMs.

SMILES (I,YR) = SEATMI (I,YR) * POPUL (I,YR)

FBRNED (I,YR) = FUELBR (I,YR) * POPUL (I,YR)

RPMS (I,YR) = RPM (I,YR) * POPUL (I,YR)

Thus, given the target RPMs, the associated fleet (POPUL), seat-miles (SEATMI), fuel burn (FBRNED) and RPMS are computed as outputs. Upon completing each of the equations shown in sections A through E for a single market, the identical computations are performed using each subsequent market's data. As may be noted, the input target RPM forecast is for the entire domestic market. The program disaggregates this forecast across markets using base year data on each market's RPM share of the total domestic market (see "USER MANUAL" for procedure to alter these factors). This establishes the RPM target within each market, totals across markets are thus consitent with the user input.

The following chapter addresses the future fleet control options available to the user. As noted in section D, above, selection of this option determines the specific form of the number of new purchases (NOBUYS) computation.

IV. FUTURE FLEET CONTROL OPTIONS

The future fleet control options control the future fleet mix and hence the forecasts of fuel burned by type of aircraft. Three alternative options are available to the user:

- Basic Option
- Fuel Efficient Option
- Design Your Fleet Option

Each of these options are discussed below.

A. Basic option--when this option is selected the last aircraft type on the input data set (within each market) is assigned all deficit (difference betwwen target and possible RPMs = RPMDIF) RPMs. Since the default data sets are arranged chronologically within each market (for example, see the YRINTR column in Table 1), exercising this option on a default data set would attribute RPMDIF to the most recent vintage aircraft. Under the basic option, the NOBUYS equation as shown in section D above is used; however, the subscript I for RPM variable is set equal to the index counter for the last aircraft considered within each market.

B. Fuel efficient option--when this option is selected all deficit RPMs are assigned to the most fuel efficient aircraft. That is, the program conducts a search across all aircraft within one market and identifies the aircraft type with the lowest SFC value (e.g., in Table 1 this represents lbs. of fuel consumed per seat-mile). Under the fuel efficient option, the NOBUYS equation as shown in section D, above, is used; however, the subscript I for the RPM variable is set equal to the index associated with most fuel efficient aircraft.

C. Design Your Fleet Option--when this option is selected all deficit RPMs are assigned to a fleet which is constructed according to the following user specified parameters:

1. The annual percentage increase the user wishes to apply to the basic input RPM share factor for existing (year of introduction--YRINTR column in Table 1--less than or equal to the base year) aircraft. The input RPM share factors, for a sample data set, are shown in the PRPM column in Table 1. The user specified percentage increase is then applied to these PRPM values. As the computer program is currently written, the percentage increase for each market is specified separately.

2. The value indicator for the existing (YRINTR less than or equal to the base year) aircraft types in each market to which item 1 is applied. Acceptable values for the vector indicating the user's preference as to the disposition of the existing aircraft types are: 0, 1, or 2. Any other values will lead to spurious results. Setting the value indicator equal to 1 for a particular aircraft type will result in the percentage PRPM increase specified in item 1 being applied to that aircraft type. Since the sum of the PRPM factors must equal 1, a comparable percentage decrease must occur to other aircraft types. If the user desires this decrease to be applied to a specific aircraft type(s), a value indicator of 2 should be assigned to that type. All of the remaining types should be assigned a value indicator of zero, their PRPM factor share would remain constant. If the user does not wish to concentrate the decrease in particular aircraft types, the value indicator "2" should not be used. That is, the remaining types should be assigned a value indicator of zero. In the latter case, (i.e., the value indicator "2" is not used) the percentage decrease is distributed equally among all types having the value indicator zero.

The above description is applicable to all years prior to the introduction of a new type aircraft into a market (YRINTR greater than the base year).

For the year a new type aircraft enters a market and for all subsequent years, the percentage increase/decrease scheme changes slightly. That is, the percentage increase described in item 3 below becomes effective, and that for existing types (as per item 1 above) ceases to be effective. Thus, all of the PRPM percentage increase is applied to the new type aircraft. The comparable decrease will be concentrated in those aircraft types having a value indicator equal to 2. Since NAFSAP assumes all of the PRPM percentage increase is to be applied to the new type aircraft, the existing types with value indicators equal to 0 or 1 will retain their PRPM factor share effective at the time of introduction of the new type. If the user does not wish to concentrate, the percentage decrease (i.e., the value indicator "2" is not used), the percentage decrease is distributed equally among all types having the value indicators equal to 0 or 1.

In an effort to simplify the above discussion, the relationship between the value indicator, its associated PRPM factor share, is restated as follows:

Years Prior to Introduction of a New Type Aircraft

1. Case where at least one existing aircraft type has a value indicator equal to 2.

Value Indicator	
1	PRPM factor share increases
2	PRPM factor share decreases
0	PRPM factor share constant

2. Case where no value indicator equals 2.

Value Indicator	
1	PRPM factor share increases
0	PRPM factor share decreases

Years During and Subsequent to Introduction of a New Type Aircraft

1. Case where at least one existing aircraft type has a value indicator equal to 2.

Value Indicator for Existing Type*	
1	PRPM factor share constant
2	PRPM factor share decreases
0	PRPM factor share constant

*All of the PRPM factor share increase is assigned to the new aircraft type.

2. Case where no value indicator equals 2.

<u>Value Inidcator for Existing Type</u>*

1	PRPM factor share decreases
0	PRPM factor share decreases

*All of the PRPM factor share increase is assigned to the new aircraft type.

3. The annual percentage increase the user wishes to apply to the basic input RPM share factor for <u>new</u> type (YRINTR greater than base year) aircraft. The percentage increase for each market is specified separately. If more than one new type aircraft appears in any one market, the percentage increase specified for new types in that market is applied to each new type aircraft. Finally, it should be noted that should new type aircraft be included in the data input set (and assuming the associated annual percentage increase is not zero), the program will disregard the percentage increase specified for the existing type aircraft once the new aircraft type is introduced into the market.

When the design your fleet option is selected the numerator of the equation to compute NOBUYS (as presented in section D, above) is modified. That is, RPMDIF is disaggregated by the aircraft type RPM share factor (using the user input PRPM values for the base year and then the compound increments, as explained in items 2 and 3 above, for the forecast years). Then the disaggregated RPMDIF is divided by the representative RPM value for the corresponding aircraft type to arrive at NOBUYS. Thus under this option, NOBUYS of each aircraft type and for each forecast year is closely controlled by the user.

Further, it should be noted that the computer program incorporates checks to ensure that the sum of the share factors across aircraft types is exactly 1.0. Only "relevant" aircraft are included in this check. Since NAFSAP computes estimates year-by-year, aircraft not yet introduced into the fleet by the current computation year are irrelevant and are excluded from the check. For example, for years prior to the introduction of a new type, if one aircraft in a market is incremented by 10 percent and their are five aircraft in that market, three of which are selected to be decreased (value indicator equal 2) and one type held constant (value indicator equal to 0), then the factor shares for the three selected for decrease are decreased by 3.3 (10/3) percent each. If two aircraft types were increased by 10 percent each, then the three types selected for decrease are decreased by 6.7 (10/3 x 2) percent each. Similarly, checks are incorporated in the program to ensure that no factor share becomes negative.

Should any factor share become negative, that factor share is set to zero for that year, and the aircraft type having the maximum factor share is reduced by the negative amount.

For any of the above options, if new type aircraft are in the market, the option will not be effective for the new type aircraft for any year prior to the introduction of that aircraft type. For example, using the first market in Table 1, for the basic option this means that additional aircraft of the existing type will be created (i.e., next most recent ventage) to satisfy RPMDIF until 1987, at which time RPMDIF will be attributed to 3EWB77. Similarly, for the fuel efficient option, using the medium range market in Table 1, the additional purchases to satisfy RPMDIF will go to the most fuel efficient existing type prior to 1984. Only for 1984 and subsequent years will the 2EWB767 be assigned the RPMDIF. For the design your own fleet option, the percentage increase specified for the new type will only be effective after they are introduced into the market. Prior to that only the existing types will be incremented.

V. TYPES OF OUTPUT

Both tables and graphic output are available from NAFSAP. The output begins with the last historical year and ends with the last forecast year. Currently outputs go from 1978 through 2005.

A. TABLES - Tabular outputs are available as follows:

- SEAT MILES
- FUEL BURNED
- RPMs
- # OF AIRCRAFT
- # OF NEW PURCHASES
- # RETIRED

ABOVE ITEMS ARE AVAILABLE:

A) FOR EACH AIRCRAFT TYPE WITHIN EACH MARKET (YEAR-BY-YEAR AND ACCUMULATED ACROSS YEARS)

B) MARKET TOTALS FOR EACH MARKET ACROSS AIRCRAFT TYPES WITHIN EACH MARKET (YEAR-BY-YEAR AND ACCUMULATED ACROSS YEAR)

C) ACCUMULATIVE TOTALS ACROSS ALL MARKETS (YEAR-BY-YEAR AND ACCUMULATED ACROSS YEAR)

D) FRACTIONAL COMPONENT THAT EACH ITEM'S MARKET TOTAL REPRESENTS OF THE TOTAL ACROSS ALL MARKETS

Tables 2 through 4 present sample tabular outputs. Table 2 shows the output for a three-engine wide body turbo-fan aircraft (3ENGWBTF) in the medium range market. Specifically, this table shows that, given the fuel efficiency input scenario, in 1979 there were 118 of these aircraft (see "POPULATION" column), consuming 15,810,000 barrels of fuel, flying 21.6 billion RPMs. The "# buys/yr" and "# retired/yr" columns show that the ten 3ENGWBTF aircraft purchased in 1978 were retired 16 years later in 1994.

Table 3 shows information similar to that presented in Table 2, except that Table 3 presents the results aggregated across all types of aircraft within one market. Specifically, Table 3 shows the results of a user specified fuel efficiency scenario for the medium range market.

Table 4 presents similar results at a higher level of aggregation. In particular, the fuel efficiency scenario results are presented across all markets.

TABLE 2

FUEL EFFICIENCY: MEDIUM RANGE MARKET

AIRCRAFT TYPE = 3ENGWATF

YEAR	SEAT-MILES (YEAR)	FUELBURNED (YEAR)	RPMS (YEAR)	POPULATION AS OF MID-YEAR	# BUYS/YR (THRU MID-YEAR)	# RETIRED/YR (THRU MID-YEAR)
1978	.3378E+11	.1484E+08	.2027E+11	.1116E+03	.1000E+02	0.
1979	.3559E+11	.1581E+08	.2160E+11	.1183E+03	.7276E+01	0.
1980	.4220E+11	.1853E+08	.2532E+11	.1387E+03	.2038E+02	0.
1981	.4852E+11	.2131E+08	.2911E+11	.1594E+03	.2078E+02	0.
1982	.5557E+11	.2441E+08	.3334E+11	.1824E+03	.2315E+02	0.
1983	.6630E+11	.2912E+08	.3978E+11	.2179E+03	.3526E+02	0.
1984	.6630E+11	.2912E+08	.3978E+11	.2179E+03	0.	0.
1985	.6630E+11	.2912E+08	.3978E+11	.2179E+03	0.	0.
1986	.6630E+11	.2912E+08	.3978E+11	.2179E+03	0.	0.
1987	.6447E+11	.2832E+08	.3868E+11	.2115E+03	0.	.6000E+01
1988	.5625E+11	.2471E+08	.3375E+11	.1849E+03	0.	.2700E+02
1989	.4834E+11	.2123E+08	.2900E+11	.1589E+03	0.	.2600E+02
1990	.4155E+11	.1843E+08	.2517E+11	.1376E+03	0.	.2100E+02
1991	.3739E+11	.1642E+08	.2243E+11	.1229E+03	0.	.1500E+02
1992	.3647E+11	.1602E+08	.2188E+11	.1195E+03	0.	.3000E+01
1993	.3546E+11	.1562E+08	.2134E+11	.1169E+03	0.	.3000E+01
1994	.3252E+11	.1420E+08	.1951E+11	.1065E+03	0.	.1000E+02
1995	.3030E+11	.1331E+08	.1818E+11	.9957E+02	0.	.7279E+01
1996	.2410E+11	.1058E+08	.1446E+11	.7919E+02	0.	.2038E+02
1997	.1773E+11	.7803E+07	.1064E+11	.5841E+02	0.	.2078E+02
1998	.1073E+11	.4712E+07	.6437E+10	.3526E+02	0.	.2315E+02
1999	0.	0.	0.	0.	0.	.3526E+02
2000	0.	0.	0.	0.	0.	0.
2001	0.	0.	0.	0.	0.	0.
2002	0.	0.	0.	0.	0.	0.
2003	0.	0.	0.	0.	0.	0.
2004	0.	0.	0.	0.	0.	0.
2005	0.	0.	0.	0.	0.	0.

TABLE 3

FUEL EFFICIENCY: SCENARIO

MARKET = MEDIUM RANGE

YEAR	SEAT-MILES (YEAR)	FUELBURNED (YEAR)	RPPS (YEAR)	POPULATION AS OF MID-YEAR	# BUYS/YR (THRU MID-YEAR)	# RETIRED/YR (THRU MID-YEAR)
1978	.7864E+11	.3754E+08	.4718E+11	.3570E+03	.3000E+02	0.
1979	.8040E+11	.3867E+08	.4824E+11	.3613E+03	.3275E+01	.3000E+01
1980	.8448E+11	.4023E+08	.5069E+11	.3657E+03	.2038E+02	.1600E+02
1981	.8854E+11	.4159E+08	.5336E+11	.3734E+03	.2072E+02	.1300E+02
1982	.9226E+11	.4338E+08	.5571E+11	.3744E+03	.2315E+02	.2200E+02
1983	.9861E+11	.4538E+08	.5917E+11	.3769E+03	.3526E+02	.3300E+02
1984	.1038E+12	.4659E+08	.6228E+11	.3896E+03	.4580E+02	.3700E+02
1985	.1052E+12	.4884E+08	.6551E+11	.4065E+03	.4481E+02	.2800E+02
1986	.1148E+12	.5103E+08	.6887E+11	.4517E+03	.6228E+02	.1700E+02
1987	.1202E+12	.5326E+08	.7210E+11	.4882E+03	.4848E+02	.1200E+02
1988	.1242E+12	.5528E+08	.7505E+11	.5227E+03	.6444E+02	.3000E+02
1989	.1305E+12	.5735E+08	.7828E+11	.5573E+03	.7059E+02	.3600E+02
1990	.1358E+12	.5988E+08	.8148E+11	.5909E+03	.6165E+02	.2800E+02
1991	.1405E+12	.6153E+08	.8455E+11	.6203E+03	.5334E+02	.2400E+02
1992	.1483E+12	.6459E+08	.8901E+11	.6573E+03	.4501E+02	.1200E+02
1993	.1562E+12	.6737E+08	.9371E+11	.6950E+03	.5366E+02	.1600E+02
1994	.1644E+12	.7101E+08	.9866E+11	.7343E+03	.6537E+02	.3000E+02
1995	.1733E+12	.7473E+08	.1039E+12	.7788E+03	.5171E+02	.7279E+01
1996	.1822E+12	.7858E+08	.1093E+12	.8314E+03	.7301E+02	.2038E+02
1997	.1919E+12	.8267E+08	.1151E+12	.8865E+03	.7592E+02	.2078E+02
1998	.2020E+12	.8656E+08	.1212E+12	.9450E+03	.8168E+02	.2315E+02
1999	.2127E+12	.9144E+08	.1276E+12	.1012E+04	.1017E+03	.3526E+02
2000	.2235E+12	.9627E+08	.1343E+12	.1065E+04	.1032E+03	.4980E+02
2001	.2357E+12	.1014E+09	.1414E+12	.1121E+04	.1011E+03	.4481E+02
2002	.2481E+12	.1067E+09	.1489E+12	.1180E+04	.1213E+03	.6228E+02
2003	.2613E+12	.1123E+09	.1568E+12	.1243E+04	.1108E+03	.4848E+02
2004	.2751E+12	.1183E+09	.1650E+12	.1308E+04	.1301E+03	.6444E+02
2005	.2895E+12	.1245E+09	.1737E+12	.1377E+04	.1395E+03	.7059E+02

TABLE 4

FUEL EFFICIENCY: SCENARIO

TOTALS FOR ALL MARKETS

YEAR	SEAT-MILES (YEAR)	FUELBURNED (YEAR)	RPMS (YEAR)	POPULATION AS OF MID-YEAR	# BUYS/YR (THRU MID-YEAR)	# RETIRED/YR (THRU MID-YEAR)
1978	.3150E+12	.1753E+05	.1895E+12	.2015E+04	.1530E+03	0.
1979	.3315E+12	.1801E+05	.1965E+12	.2075E+04	.6574E+02	.1000E+02
1980	.3449E+12	.1859E+05	.2067E+12	.2083E+04	.9285E+02	.8500E+02
1981	.3626E+12	.1946E+05	.2176E+12	.2110E+04	.1004E+03	.6500E+02
1982	.3786E+12	.2018E+05	.2272E+12	.2113E+04	.1174E+03	.1220E+03
1983	.4021E+12	.2079E+05	.2413E+12	.2121E+04	.1431E+03	.1560E+03
1984	.4232E+12	.2105E+05	.2539E+12	.2035E+04	.2185E+03	.3040E+03
1985	.4452E+12	.2152E+05	.2671E+12	.1996E+04	.1544E+03	.2330E+03
1986	.4680E+12	.2238E+05	.2808E+12	.2122E+04	.2268E+03	.1010E+03
1987	.4980E+12	.2329E+05	.2940E+12	.2227E+04	.1588E+03	.5400E+02
1988	.5103E+12	.2407E+05	.3062E+12	.2307E+04	.1755E+03	.9600E+02
1989	.5320E+12	.2484E+05	.3192E+12	.2368E+04	.2111E+03	.1500E+03
1990	.5536E+12	.2559E+05	.3322E+12	.2438E+04	.1874E+03	.1180E+03
1991	.5746E+12	.2629E+05	.3448E+12	.2482E+04	.1747E+03	.1300E+03
1992	.6045E+12	.2746E+05	.3629E+12	.2577E+04	.1834E+03	.8900E+02
1993	.6365E+12	.2867E+05	.3821E+12	.2668E+04	.2005E+03	.1090E+03
1994	.6705E+12	.2978E+05	.4023E+12	.2731E+04	.2555E+03	.1930E+03
1995	.7058E+12	.3135E+05	.4235E+12	.2808E+04	.2193E+03	.6974E+02
1996	.7431E+12	.3308E+05	.4459E+12	.3044E+04	.2566E+03	.9289E+02
1997	.7824E+12	.3473E+05	.4694E+12	.3216E+04	.2725E+03	.1004E+03
1998	.8237E+12	.3656E+05	.4942E+12	.3397E+04	.2585E+03	.1174E+03
1999	.8671E+12	.3848E+05	.5203E+12	.3593E+04	.3590E+03	.1631E+03
2000	.9129E+12	.4051E+05	.5478E+12	.3783E+04	.4082E+03	.2185E+03
2001	.9612E+12	.4265E+05	.5767E+12	.3983E+04	.3545E+03	.1944E+03
2002	.1012E+13	.4450E+05	.6071E+12	.4193E+04	.4365E+03	.2268E+03
2003	.1065E+13	.4727E+05	.6392E+12	.4414E+04	.3803E+03	.1588E+03
2004	.1122E+13	.4973E+05	.6729E+12	.4647E+04	.4091E+03	.1759E+03
2005	.1181E+13	.5239E+05	.7084E+12	.4892E+04	.4560E+03	.2111E+03
STOP						

B. <u>GRPAHICS</u> - FUEL BURNED BY YEAR PLOTS ARE AVAILABLE AS FOLLOWS:

A) SEPARATE PLOT FOR EACH MARKET SHOWING FUEL BURNED BY EACH AIRCRAFT TYPE IN THAT MARKET

B) A PLOT SHOWING THE TOTAL FUEL BURNED FOR EACH OF THE MARKETS, TOGETHER WITH THE TOAL ACROSS ALL MARKETS

C) A PLOT OF ACCUMULATIVE FUEL BURNED, I.E., FUEL BURNED BY 1ST AIRCRAFT TYPE IN 1ST MARKET IS PLOTTED, THEN FUEL BURNED BY 2ND AIRCRAFT TYPE IN 1ST MARKET PLUS THE PRECEEDING IS PLOTTED, AND SO ON ACROSS ALL AIRCRAFT TYPES AND MARKETS.

Exhibits 1 through 3 present sample graphics output. Exhibit 1 shows the results of a fuel efficiency scenario for the medium range market for each aircraft within that market. This graph is consistent with the Table 1 sample input data set. Exhibit 1 shows that barrels of fuel burned increases for 3 ENGWBTF until 1984. In 1984, when 2 EWB767 are introduced, RPMDIF is assigned to the latter relatively more fuel efficiency aircraft, resulting in a rapid rise in fuel burned for this type of aircraft. As shown in Table 2, the last 3 ENGWBTF was purchased in 1983, under this scenario. Exhibit 1 reflects the 16 year useful life assumption for 3 ENGWBTF and shows this aircraft type to go to zero in 1999.

Exhibit 2 shows fuel burned by year, for each market total. Total fuel burned across all market is also shown. The close proximity of the long and medium range market is due to market definition for this sample "run." That is, the market definitions presented in Chapter II and consistent with Table 1 were used. Since for the base year the long range market accounts for 21.4 percent of the total RPMs and the medium range market accounts for 24.6 percent, the close proximity of the curves representing these two markets is understandable. The uppermost curve in Exhibit 2 shows total fuel burned across all markets, corresponding to Table 4 output. It shows, for this scenario, fuel burned increasing from approximately 179 million barrels in 1978 to about 524 million barrels in 2005.

Finally, Exhibit 3 shows cumulative fuel burned as each aircraft type enters each market. That is, the lowest curve shows fuel consumed by 4ENGNBTF in the first market considered. The next highest line shows fuel consumed by 4ENGNBTF plus fuel consumed by 4ENGWBTF in the first market considered. After all aircraft in the first market are cumulated, the aircraft in the second market are added to these results one-at-a-time. Finally, aircraft in the third market are considered in the same manner. The uppermost curve corresponds to the total across all markets.

EXHIBIT I

U.S. Fleet Fuel Usage Forecast

MEDIUM RANGE MARKET

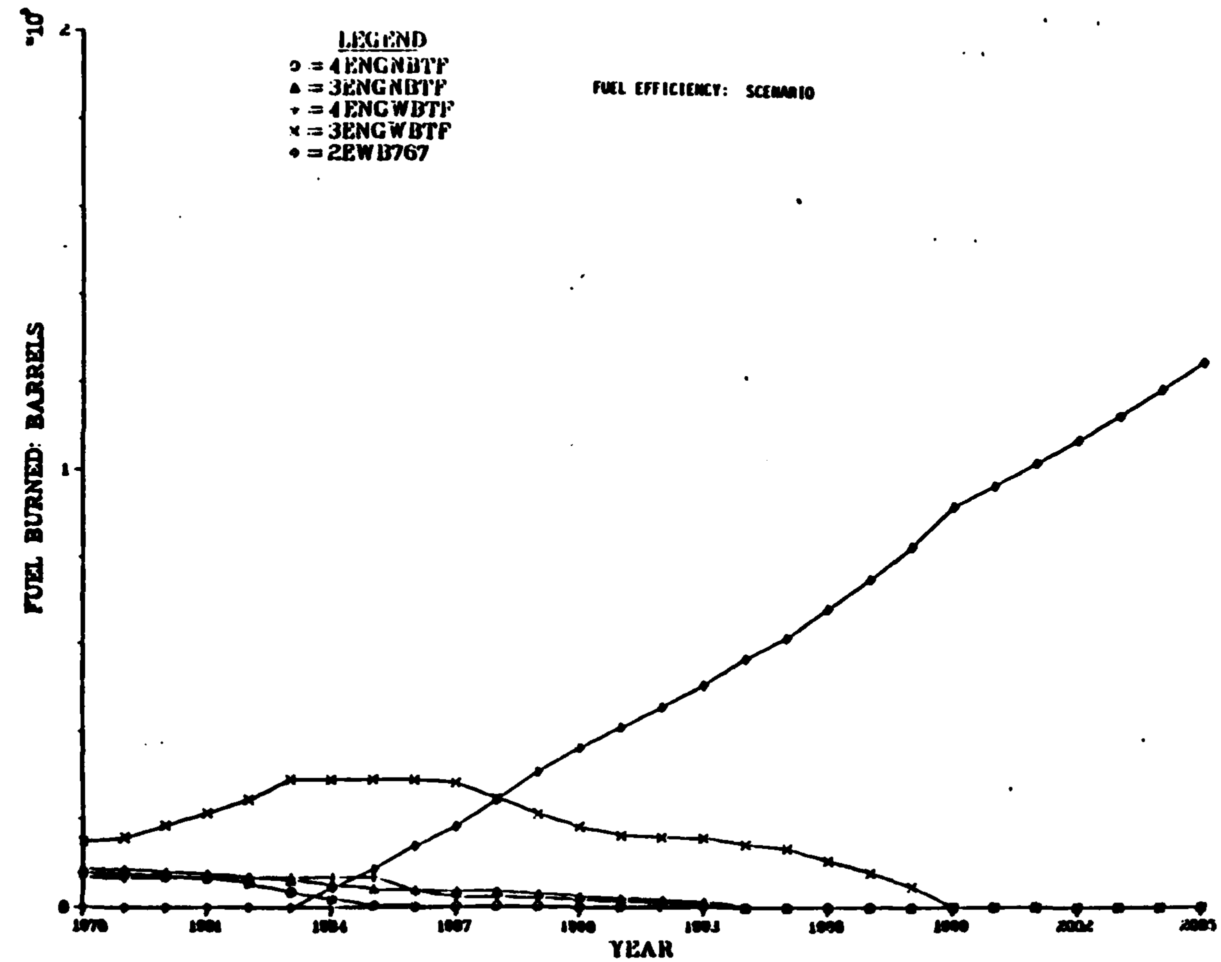


EXHIBIT 2

U.S. Fleet Fuel Usage Forecast

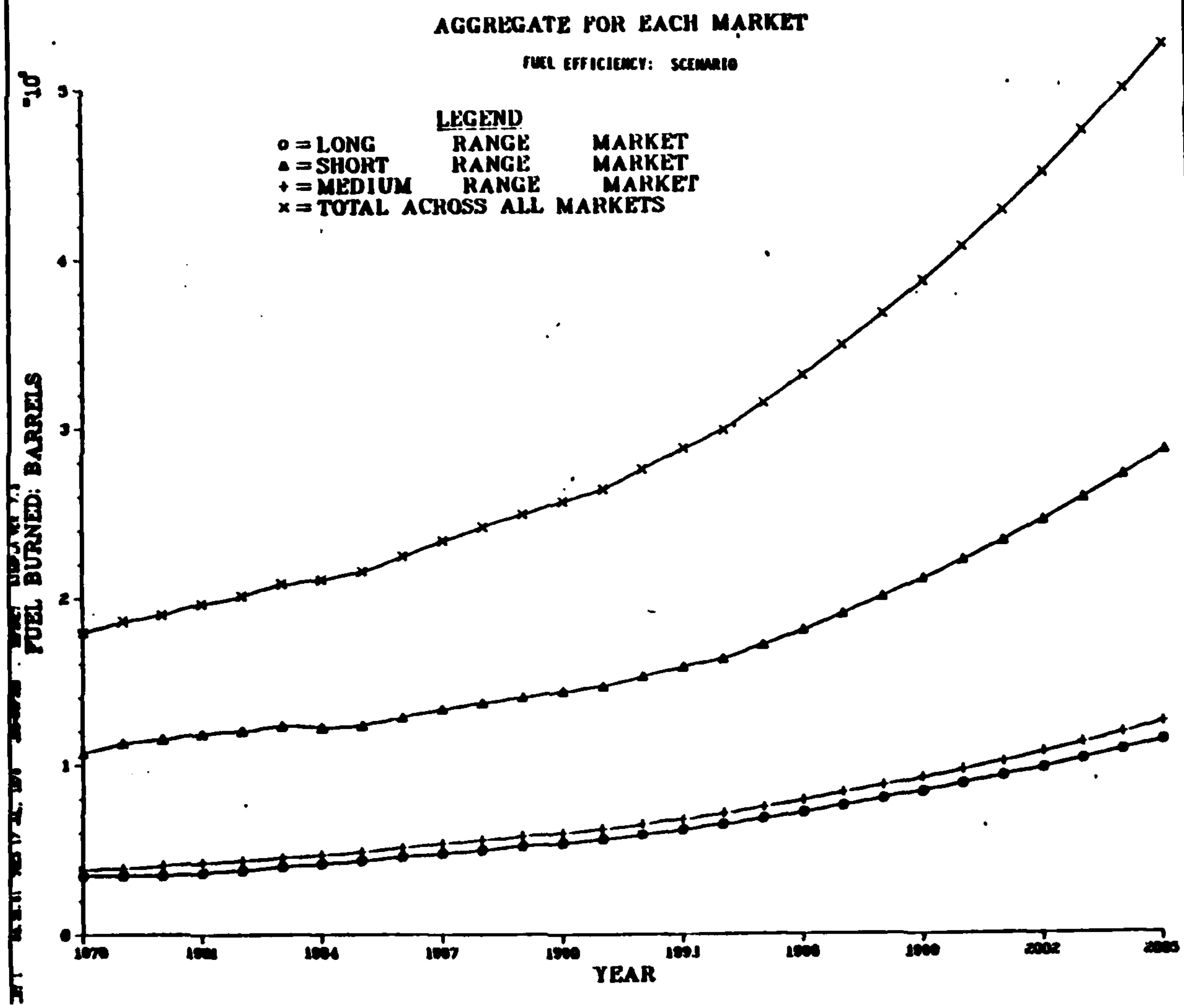
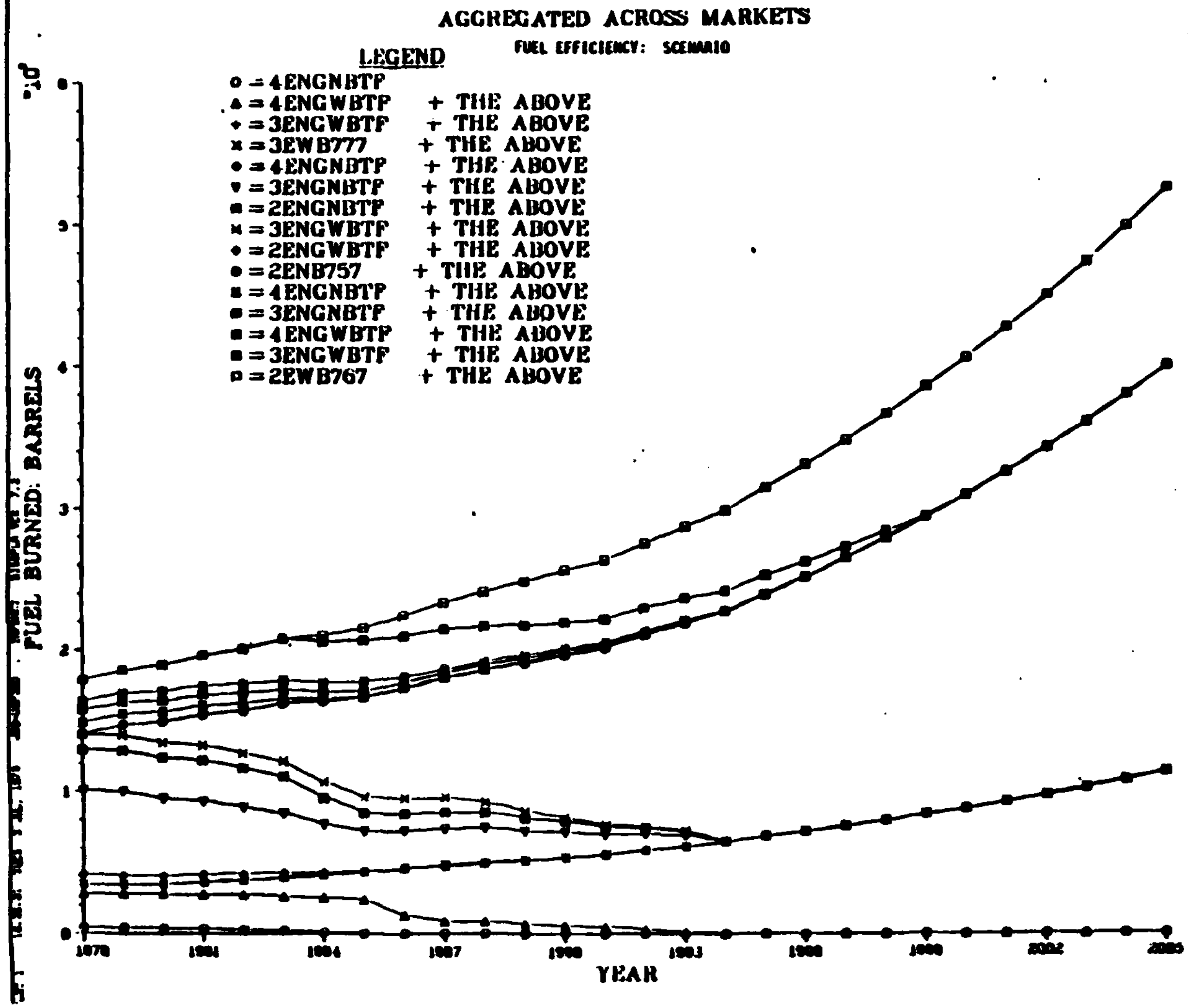


EXHIBIT 3

Forecast U.S. Fleet Fuel Usage Distribution



VI. SCENARIO ANALYSIS

The type of scenario analysis that may be generated using NAFSAP is illustrated in Table 5. This table presents information derived from five different scenario "runs" of NAFSAP. The column headings indicate the scenario options chosen by the user. As explained in Chapter V, above, in the fuel efficiency scenario all deficit (target less possible = RPMDIF). RPMs are attributed to the most fuel efficient aircraft. For the basic option, all deficit RPMs go to the most recent vintage aircraft. The inputs presented in Table 1 are used for the fuel efficiency and basic options. The third column heading indicates the "design your fleet option." Table 1 data is also used as the input when exercising this option. Specifically, a 1% increase is applied to the last existing type of aircraft in the long and medium range markets (i.e., 3 ENGWBTF in both markets, see Table 1), and to the last two existing types (2ENGWBTF and 2ENGWBTF, see Table 1) in the short range market. One new type of aircraft is entered in each market (see Table 1), and their RPM market share is increased at 2% per year. That is, each of the new types enters with a 5% factor share (3% PRPM factor as specified in Table 1, plus 2% increase) of RPMDIF and receives a 2% annual increase. As explained in Chapter V, the PRM factor share and associated increments for new type aircraft is effective only for, and subsequent to, the year it is introduced (YRINTR in Table 1) in the fleet. In addition, once the new type aircraft are introduced into the fleet, the factor share increments (1% in this example) are no longer applied to the existing type aircraft.

TABLE 5

CONCLUSIONS FROM SCENARIO ANALYSIS: 1978-2005

(ALL FIGURES EXPRESSED IN MILLIONS)

	SCENARIO				
	FUEL EFFICIENCY	BASIC	1 NEW EACH MARKET (@ 2%)*	LONG = 2 NEW; OTHER = 1 NEW AT 2%**	AT 10%***
TOTAL FUEL BURNED (BARRELS)	8,426	9,054	10,120	10,090	9,558
COST AT $.50/GAL.	$176,946	$190,134	$212,520	$211,890	$200,718
BARRELS IN EXCESS OF EFFICIENCY	0	628	1,694	1,664	1,132
COST IN EXCESS OF EFFICIENCY AT $.50/GAL.	0	$ 13,188	$ 35,574	$ 34,944	$ 23,772

* Each new type enters with 5% market share with 2% annual increase.

** In long range market B-767 enters with 10% and B-777 enters with 5% market share with 2% annual increase. See * for other markets.

*** In long range market B-767 enters with 18% and B-777 enters with 13% market share with 10% annual increase. B-757 enters in short and B-767 enters in medium range market, each enters with a 13% market share with 10% annual increase.

The two right-most columns in Table 5 show results for two additional design your fleet scenarios. Both of these scenarios are very similar to the preceeding scenario. However, in the latter two scenarios, two new aircraft are included in the long range market. Specifically, 2EWB767 aircraft are entered in the long range market along with the 3EWB777. As indicated in the footnotes to Table 5, for the column labeled "AT 2%," the 2EWB767 enters with a 10% share and the 3 EWB777 enters with a 5% market share, both receive 2% annual increases. To illustrate differences between the two scenarios where two new types of aircraft are introduced, the market share factors are altered for the new aircraft types. The footnote associated with the column label "AT 10%" defines the relevant market shares for the final scenario. For the two scenarios utilizing two new types of aircraft in the long range market, the scenario options related to the existing types of aircraft are identical to that presented in the immediately preceeding paragraph.

Table 5 shows that under the fuel efficiency scenario 8,426 million barrels are consumed at a cost of approximately $177 billion dollars. Results for the other scenarios may be compared to those for the fuel efficiency scenario to determine fuel consumption and costs in excess of the fuel efficiency case. For example, the third right-most column, where one new aircraft type is introduced in each market, shows the most extreme results. Under this scenario 10,120 million barrels fo fuel are consumed at a cost of approximately $212.5 billion dollars. Comparing these results to comparable figures fo the fuel efficiency scenario shows that over the forecast period almost 2 billion barrels of fuel are consumed in excess of the fuel efficiency results at an "extra" cost of about $36 billion dollars.

Obviously, Table 5 is only one example of the manner in which NAFSAP can be used to conduct scenario analysis. Scenarios can be tailored by the user of NAFSAP to suit his/her own needs, and the results may be compare accordingly. In addition, results similar to Table 5 could be obtained for fleet composition comparisons, or seat-miles comparisons. Similarly, such tables can be generated for each market described by the user to NAFSAP. The wide range of options available to the user provides NAFSAP with great flexibility, thus making it a useful tool to analyze a wide variety of problems.

APPENDIX A

THE COMPUTER COMPANY
1211 CONNECTICUT AVENUE □ SUITE 708 □ WASHINGTON, D.C. 20036 □ (202) 467-6340

August 24, 1979

Charles J. Hoch
Federal A dation Administration
800 Independence Ave., S.W.
Washington, D.C. 20590

Subject: Technical assistance in retrieval of C.A.B. data for various mileage breakdowns by aircraft type.

Reference: Discussion between Steve Vahovich of F.A.A. and Thomas Morrison of The Computer Company on August 22, 1979.

Dear Mr. Hoch:

Per your request, The Computer Company is pleased to present this task description to provide data for your forecasting purposes.

Background

The Computer Company provides ER 586 data online to the F.A.A. but the request in this particular case is best suited to a batch run. This project will modify existing F.A.A. software developed by T.C.C. to include additional data items and then provide the report.

Task Description

(1) The Computer Company will develop the software necessary to provide a report with four components. The first three components will be aircraft data for three specified mileage markets. The fourth will be totals for aircraft without regard to milegage.

(2) Each component will contain calculated RPMS, Passengers, Load Factor, Average Passenger Trip Length, the percent of an aircrafts RPM's, the average available seats per aircraft mile, average block to block speeds and block hours.

(3) The aircraft types will be broken out individually as types (ie. 727, 737, 747) and accumulated ~~as groups~~ (ie. narrow body 2 engine, wide body 2 engi~~ne, etc.~~).

(4) The report will be provided for the most current 12 months.

(5) The report will be output as a printed report and as a tape.

Deliverables

(1) A printed report.

(2) A data Tape.

Staffing

The Computer Company will have available senior programmers/analysts to perform the described tasks.

Cost Estimate

The estimated level of expenditures is as follows:

Senior Programmer/Analyst	16 hours	$480.00

The maximum estimated computer cost is $1500.00.

The computer cost can not be exceeded without an explicit approval by the F.A.A. contracting officer.

August 24, 1979
Mr. Charles Hoch
page 3

Schedule

Work on this task will be completed within 5 full working days after written authorization to proceed.

Sincerely,

The Computer Company
APL Division

Thomas G Morrison / RRD

Thomas G. Morrison
Manager, Aireast

TGM/dlb

Approved: Charles J. Hoch — Date 8/27/79

Approved: Arthur Dahmer — Date 8/27/79

NATIONAL AVIATION FUEL SCENARIO ANALYSIS PROGRAM (NAFSAP)

VOLUME II: USER MANUAL

STEVE VAHOVICH, AEE-200

SEPTEMBER 1979

I. INTRODUCTION

STEP 1:

To access NAFSAP, sign-on the Computer Science Corp. (CSC) computer system using the following procedure:

Dial: 937-0530 (access phone number will be different outside of the Washington, D.C. Metropolitan Area)

when green light on copuler lights, type: E (cr)* System will respond "CENTER," and user types NN (cr). Then type:

GPS, user computer number, password, project code (cr).

You are now on the CSC computer system.

STEP 2:

The user must now set the options for the scenario he wishes to input to NAFSAP. Three general categories of options may be set by the user:

- o aircraft specific options
- o target RPM's options
- o future fleet control options

*cr means depress carriage return button

Since the aircraft specific and target RPM's options contain the most recent historical and forecast information as their default values, these options will generally be exercised only when these data bases require update or for special (variations on history or alternative forecasts) analysis runs. Thus, a description of these options is presented later in the "Data Base Update" chapter. The following chapter describes the procedure to exercise the future fleet control options.

Appendix B-1 provides a copy of the FORTRAN code of the computer program comprising NAFSAP input data base and Appendix B-2 provides a sample input data base. Since all changes in options and data bases are accomplished via the REVISE command, and since the content of this REVISE command is specific to the particular values the user wishes to specify (the combinations are almost infinite), it is not practical to list the exact REVISE command for each option. However, all changes in options and data bases do follow the general form of the REVISE command as given in Guide to General Programming Subsystem (GPS), pages 23-32. The user is referred to that document for further detail. Appendix B-3 presents the computer code for the three separate programs that generate the graphics results.

STEP 3:

Having set all desired options and completed all modifications the user types in the following commands:

SWITCH IN$: specify input data set name

(this statement identifies the input data set to NAFSAP)

SWITCH OUT$: <u>specify any unique output data set name</u>

(all tabular output from NAFSAP will reside on this file for user retrevial)

*EQUATE 4 BET3IN

*EQUATE 8 BET4IN

EQUATE 3 <u>specify the "target RPM" in our file name</u>

(this statement identifies the target RPM input file)

EQUATE 16 <u>specify any unique output data set name for graphs</u>

(identifies the file to which outputs are written and which are used as inputs by the DISPL2 graphics program)

EQUATE 18 <u>specify any unique output data set name for graphs</u>

(identifies the file to which outputs are written and which are used as inputs by the DISPL3 graphics program)

EQUATE 17 <u>specify any unique output data set name for graphs</u>

(identifies the file to which outputs are written and which are used as inputs to the DISPLA4 graphics program)

---

*These files are utilized by subroutine UNIT04 as presented in Appendix B-1. This subroutine simply reads and writes the data presented in lines 1 through 35, Appendix B-2. This data relates to certain production cost characteristics for new type aircraft, which currently are not used by NAFSAP. Allowances are made for these files in the current version of NAFSAP to provide space for future expansion of NAFSAP to production cost problems. Alternatively, these files may be utilized by the user for special problems he/she wishes to consider.

FR5 BET2PR

(compiles the Fortran code in NAFSAP)

LINK BET2PR

(creates an executable module for the computer to process)

BET2PR

(executies NAFSAP, writing all tabular and graphics related output to specified files)

SWITCH IN$:, CLOSE OUT$:, CLOSE

(releases all files from the current computer job stream run)

SAVE <u>specify the same data set name used in SWITCH OUT command</u>

(saves the results of the current run; outputs for graphics programs are automatically saved)

Either of the following two commands may now be used to "claim" the tabular output:

LIST <u>specify same data set name used in SAVE command</u>

(lists the results at the terminal)

OUTPUT file name used in save   high speed printer number

(causes the output to be printed at the high speed terminal)

STEP 4:

To obtain graphic output from a pen plotter the following additional statements are required:*

EQUATE 28 specify any unique file name for graphics output

(identifies file to which output of graphics program is written)

LINK, HIER, MORE specicy desired graphics program name

(creates an executable module and allows for special graph control statements)

USE $DISS1, $DISS2

(allows use of DISSPLA graphics control statements)

QUIT

(attach the DISSPLA statements to the executable module)

specify desired graphics program name

(executes the specified graphics program; same name as specified in LINK)

*Alternative graphics programs; DISPL2, DISPL3, DISPL4, are discussed in Chapter IV. All these programs utilize DISSPLA, a commonly available graphics pagkage. See the DISPLA Reference Manual for further detail.

SAVE <u>specify same data set name used in EQUATE 28</u>

(saves the results of the graphics program)

DISSPOP, ZET <u>specify same name used in SAVE</u>

(executes post processor which translates results of the graphics program to machine readable code used by the pen plotter)

cr

(depressing the carriage return button will cause the plot to begin on the pen plotter)

<u>STEP 5</u>:

Upon completion of the desired output the user "signs-off" the system with the following command:

OFF

TABLE M-1: FUTURE FLEET CONTROL OPTIONS

	FUEL EFFICIENCY	BASIC	USER FLEET: 1 New Each Market	USER FLEET: Long = 2 New, Others = 1 New At 2%	USER FLEET: Long = 2 New, Others = 1 New At 10%
Indicate Fleet Design (INDIC=)	2 *	0 *	1 *	1 *	1 *
# of MRKT = 1 Exising Types Incremented (NOLD1=)	NA	NA	0,0,1,1	0,0,1,1,1	Same as 2%
# of MARKT = 2 Exising Types Incremented (NOLD2=)	NA	NA	0,0,0,1,1,1	Same as 1 New	
# of MRKT = 3 Exising Types Incremented (NOLD3=)	NA	NA	0,0,0,1,1	Same as 1 New	
% Increase Applied to NOLD (POLDTP=)	NA	NA	.01*	.01*	.01*
% Increase Applied to New Types (PNEWTP=)	NA	NA	.02*	.02*	.10*

* A vector of 3 elements, each element is equal to the value shown.

II. FUTURE FLEET CONTROL OPTIONS

Table M-1 shows the three categories of future fleet control options: (1) fuel efficiency; (2) basic; and (3) user fleet. These options are described in Volunm I of the documentation of the NAFSAP mode. Volume I also presents the results of exercising the options for the exact values specified in Table M-1.

Each of the row labels in Table M-1 contains a variable name in the parenthesis. These variable names correspond to those used in the computer program code presented in Appendix B-1 (see subroutine Buys 2). Each variable name identifies a vector. The elements of the INDIC, POLDTP AND PNEWTP vector relate to the markets. For example, assuming the data input file (see discussion in Chapter III) is ordered long, short, and then medium market, the first element in each of these vectors relates to the long range market, the second element relates to the short range market, and the last relates to the medium range market.

The specific values presented in the first row for Table M-1 are the possible alternatives that may be specified in the computer code for the INDIC = 2 to use the fuel efficiencyoption; set INDIC = 0 to exercise the basic option; or set INDIC = 1 to use the user fleet option.

As illustrated in Table M-1, the "NA" for the remaining rows of the fuel efficiency and basic options means that no matter what value the user specifies for the associated variables (named in parenthesis), these values will be ignored by the computer program. That is, for these two options the computer program automatically determins, once it "sees" a value of "2" or "0" specified for INDIC, that it has all the information it needs to satisfy the user's desired option. To repeat, the "NA" in Table M-1 does not mean that the user sets the values for the associated variables equal to "NA" (this may result in a computer program error),vector but rather that these variables may take on any arbitrary numerical integer value (i.e., does not contain a decimal point). However, the user must specify meaningful values for the variables listed in rows 2 through 6 of Table M-1 of the user fleet option is exercised. This is discussed in the following paragraph.

As shown in Table M-1, user supplied values to the variables listed in rows 2 through 6 describe to NAFSAP the particulars of the user fleet option. There are an infinite number of combinations of values the user may specify under this option. Assuming the input data is ordered long, short and then medium range market, NOLD1 relates to the long range market, NOLD2 to the short, and NOLD3 to the medium range market. The value of each of the elements of these NOLD vectors indicate whether the PRPM factor for a particular aircraft rype is to be increased, decreased or held constant. The order of the elements in these vectors must correspond to the order of the aircraft types in the input data set for each market. For example, assume the above market order, and assume within the long range market that data for aircraft types and entered as follows: 4ENGNBTF, 4ENGWBTF, 3ENGWBTF, 3EWB777 (see Table 1, Volume I). Then the particular value indicators shown in the case where one new aircraft type is introduced in each market, would result in an increase (by the value specified in POLDTP) in the RPM factor share for 3ENGWBTF (i.e., third element of the NOLD1 vector has a value of 1) for all years prior to the introduction of the new type of aircraft. A corresponding decrease would occur to the RPM factor share for 4ENGNBTF and 4ENGWBTF (both having a value indicator equal to zero). Finally, when the new type of aircraft (3EWB777) is introduced into the market, say 1987, its RPM factor share would be increased (by the value specified in PNEWTP) and the corresponding decrease would be equally distributed across all existing aircraft types. The meaning and use of the value indicators in the NOLD vectors are discussed in detail in Volume I, Chapter IV, Section C.2. These values are set via the "data statements" in subroutine Buys (see Appendix B-1).

The remaining vectors listed in Table M-1 (POLDTP and PNEWTP) must be expressed in real terms (i.e., with decimal). The value of the elements in these vectors indicate the percentage increase applied to aircraft types as indicated by the NOLD vectors. The first value of the POLDTP vector existing aircraft types in the NOLD1 vector, the second element applies to the NOLD 2 vector, the third element applies to the NOLD 3 vector. A similar statement holds for the PNEWTP vector except that the specified increase applies to new aircraft types only. As shown in Table M-1 these vectors are used only for "user fleet" option. As specified increase applies to new aircraft types only. As shown in Table M-1, under the "1 NEW EACH MARKET" column for existing aircraft (as specified by user set values for NOLD1, NOLD2, NOLD3) are incremented by 1% (POLDTP = .01) per year. Simarily, this same colunm in Table M-1 shows that the PRPM value for each new type aircraft is incremented at 2% (PNEWTP = .02) per year.

Although Table M-1 shows the INDIC, POLDTY, and PNEWTP values to be the same for each market, these values may vary across markets. For example, the fuel efficiency option may be chosen for the first market, the basic option for the second market, and the user fleet option for the third market. The latter is achieved by specifying the following values for the INDIC vector: 2, 0, 1. Simarily the rates of increase applied to the RPM factor shares within each market, for both POLDTP and PNEWTP vectors, may be varied by market. The remaining paragraphs of this chapter present some additional notes of information.

As noted in Volume I, Chapter IV, Section C, PNEWTP is effecitve only for years during and after the new type aircraft is introduced into the market, and values for POLDTP are ignored for this period. Similarly, if the computer program is processing any year prior to the year of introduction of a new aircraft type (YRINTR variable in Table, Volume I), the value specified for POLDTP is used as the increment for ėxisting types, and PNEWTP (and its associate PRPM value) for new type aircraft are ignored.

The user should note that setting POLDTP or PNEWTP equal to zero will not negate the option of utilizing the basic input data (i.e., PRPM values) for either existing or new type aircraft, but will only negate the increments. If the user desires to include only existing types of aircraft, then the data base must be modified to exclude aircraft types whose YRINTR value (see Volume I, Table 1) is greater than the default (1978) or user set base year value. The following chapter describes this procedure.

Finally, it should be noted that POLDTP and PNEWTP may take on any real values from 0.0 to 1.0. The values specified are applied as percentage increases to the base year PRPM values, resulting in new PRM factor shares for the first relevant forecast year. As pointed out in Volume I, Chapter IV, Section C, the computer program has a series of built in checks to ensure that the relevant RPM factor shares alway sum to 100% (i.e., 1.0) and will balance the PRPM factors on each iteration (year) to achieve this result.

III. DATA BASE UPDATE

A. AIRCRAFT SPECIFIC DATA

Appendix B-2 presents a "sample data base" input to NAFSAP. The input is read by the "main" program BET2PR beginning with line 48 in the computer code presented in Appendix B-1. The following paragraphs present a item-by-items description of the input parameters, as presented in Appendix B-2*.

As noted in Chapter II, data lines 1 through 35 (Appendix B-2) are production cost characteristics to be used in future expansion of the application of NAFSAP. These data items are read by the subroutine UNIT04 (see Appendix B-1), but are not currently utilized by NAFSAP.

The first required line of input data (line 36 in Appendix B-2) specifies the name of the market that is to be associated with the data items to follow.

The next item of data (lines 37 through 41, Appendix B-2) are reserved for future data base and program expansion--any values may be entered here, they are read by the program (line 53, Appendix B-1) but are not utilized.

*This data set may be modified, as explained in this volume, Chapter I. Alternatively, the user may create a completely new data set by typing in his desired values, matching input columns and type (real/integer) data to the read format statements. For FAA in-house users, the data set listed in Appendix B-2 resides in their system under the name BETDA5; alternative available on-line data sets include BETDA4 (containing only existing aircraft types) and BETDA7 (containing 2 new aircraft in the long range market, and 1 new aircraft type in other markets), as presented in Appendix B-4.

The next data item are load factors (lines 41 through 44, Appendix B-2). One load factor value is entered per year. The first entry is for the base year and the remainder are for the forecast years. These load factor apply to the market, i.e., to each aircraft type within the market. As with all the following data items, they may be specified differently in each market. The read statement for load factors appears on line 61 of the computer program code.

The next data item (line 45, Appendix B-2) specifies the number of existing aircraft types in the market. The real statement for this data item appears on line 69 of the compter program code.

The next data item (line 46, Appendix B-2) itemizes the aircraft type characteristics for one aircraft type in the market. These eight characteristics, corresponding to the eight variables listed in the read statement (line 76, Appendix B-2), define the simulation parameters for an aircraft type. Using the values specified in line 46 of the sample data base in Appendix B-2, these characteristics may be defined as follows. For the long range market, the first four-engine narrow body turbo-fan (4ENGNBTF) aircraft was introduced in 1960; in the base year, the typical aircraft of this body type has 150 seats, consumes .153 lbs. of fuel per seat-mile, flew 405mph, flying 2,759 hours, has a useful life of 16 years from date of purchase, and its share of total PRMs for that market is .158. The user should note that values entered for these items should relate to the way the user wishes to define the three market. That is, the data values cited in this example are for the long range market defined as 2,500 statute miles or more. If, for example, the user wished to define the long range market as 1,500 statutue miles or more, these values would be different.*

The next data item (lines 47 through 48, Appendix B-2) lists the number of aircraft purchases (for the aircraft type described in the immediately preceding data item) for each of the 16 years of historical data required by the program. These 16 years of data are accumulated (after retirements--see following paragraph--are substracted out) to form the base year fleet*. The read statement for this item appears on line 87 of the computer program code.

The next data item (lines 49 through 50, Appendix B-2) lists the number of aircraft retired (for the aircraft type described above) for each of the 16 years of historical data. These retirement are substracted form the number of historical purchases, and the net result is accumulated to arrive at the base year fleet.** The read statement for this item appears on line 91 of the computer program code.

---

*With one exception, all of the information required to define these characteristics can be obtained from the Computer Company by contacting Tom Morrison or Rob Durbin. See Appendix A, Volume I, for sample Technical Assistance Request used to obtain such information. Fuel intensity figures are available in the literature, e.g., page 191 of Transportation Energy Conservation Data Book: Edition 2.

**Data for aircraft purchases and retirements are available from The Computer Company. See immediately preceding footnote.

Beginning with line 51 of the sample data base presented in Appendix B-2, the aircraft characteristics, number of buys, and number of retires data are repeated for each type of aircraft the user wishes to introduce into the first market. The number of such data sets must be exactly equal to the value specified for the number of existing aircraft types. As show in the sample data base (line 45, Appendix B-2), there are three existing aircraft types, and the related data inputs are presented on lines 46 through 60.

The next data item specifies the number of aircraft types the user wishes to modify (line 61, Appendix B-2). If modifications of any of the aircraft type characteristics are desired, an integer values should be entered, followed by a separate input data line describing the aircraft modification characteristics values in exactly the same format as described for line 46 above. Modification input data is read in line 105 of the computer code. The model assumes that a modification occurs over a two-year period. In the year a modification begins (comparable to the year of introduction parameter described for line 46 input), the aircraft characteristics are assumed to be the average of the old and the new values. In subsequent years the new (modification) values are used. As shown in line 61 of the sample data set (Appendix B-2), the no modification case is indicated by a zero entry.

The next data item (line 62, Appendix B-2) specifies the number of new aircraft types to enter the first market. This item is read in line 132 of the computer program code. As shown in the sample data set, one new aircraft type is entered into the long range market. The aircraft characteristics describing the new aircraft type(s) are listed on the following input line(s). In the sample data base presented in Appendix B-2, line 62.01 presents the aircraft characteristics for the new type. These characteristics are defined identical to those presented for existing aircraft types (see definitions given above for data input line 46). If the user does not wish to enter new aircraft types, a zero is entered for line 62, and, of course, no data would be entered to describe the new type aircraft.

All of the input data required to executed NAFSAP for one market has now been considered. The entire process is now repeated for the second market. In the sample data base presented in Appendix B-2, data input for the second market begins in line 63 and extends through line 99.01. Finally, input for the third market is presented. Current computer program dimension statements limit market disaggregation to the conventional three market breakdown.

Before leaving the aircraft specific data, the user should note that the RPM factor share charateristics (i.e., as presented in the sample data base, Appendix B-2) for exising aircraft types should sum to 1.0 within each market.* Otherwise, NAFSAP will balance the RPM factor shares to sum to 1.0 "automatically," however, the exact proportions specified by the user will be altered. When new types enter, their RPM factor share is included in the check on the sum and exising types receive the corresponding decrease according to the user determined values in the NOLD vectors (see Volume I, Chapter IV, Section C. 2).

B. TARGET RPMs

Appendix B-2 presents a default data set, labeled DOMRPM, specifying the forecasted target RPMs for the U.S. domestic fleet. The entry in line 1 is for the base year, subsequent entries are for each forecast year. The read statement for this data item appears on line 74.003 of the computer program code (Appendix B-1). The user may substitute any target RPM values he wishes to analyze. The FAA RPM forecasts are published and updated annually in "Aviation Forecasts" (Office of Aviation Policy).

The user should be aware that NAFSAP disaggregates the forecasted total U.S. fleet domestic RPM input across the three markets using the most recent historical distribution available (base year data). This establishes a target RPM for each market. The disaggregation factors appear on lines 46.02 through 46.04 of the computer program code presented in Appendix B-1. The value of these factors are, of course, dependent on the user's definition of the markets. The factors presented in the computer program code relate to the long range market defined as 2,500 statute miles or more, a 1,500 - 2,499 mile medium range market, and a short run market of less than 1,500 miles. The user may alter these factors to comply with any desired market definition, ensuring that the factors sum to 1.0. For example, for the most recent update of the NAFSAP data base, the short range market is defined as 400 miles or less, the medium as 401 to 1,000 miles, and the long as 1,001 miles or more. In this case, the factors are FSHORT =.104, FMED = .267, and FLONG = .629, respectively. The input data set correspnding to this market definition is presented in Appendix B-4, and is labeled "BETDB1".

*This dicussion relates only to the case where the user elects to use the "design your own fleet option." The RPM factor share are ignored for the other options.

IV. GRAPHICS

Appendix B-3 presents the computer programming code for the three graphics programs associated with NAFSAP. Each of these programs are discussed below. All of the graphics programs "automatically" accept the output generated by the execution of the computer code specified in Appendix B-1 as their input. That is, no itermediate data base building step is required. All of the graphics programs utilize the DISSPLA graphic package.* Detailed information on the DISSPLA graph control statements utilized is presented in the DISSPLA Reference Manual.

A. DISSPL2 PROGRAM

Exhibits B-1, B-2 and B-3 present samples of graphics displays that are generated by the DISSPL2 program. Fuel burned, in millions of barrels, is presented along the vertical axis, and years are given on the horizontal axis. Exhibit B-1 shown values for these coordinates plotted by type of aircraft for the long range market. Similar displays are shown for the short range market (Exhibit B-2) and the medium range market (Exhibit B-3). All three of these graphs are generated in a single execution of the DISSPL2 program. Current computer program "dimension" limits allow space for up to (and including) ten aircraft types in each market.

*DISSPLA is a proprietary software product of Integrated Software Systems Corporation, San Diego, California, and is available on many computer systems.

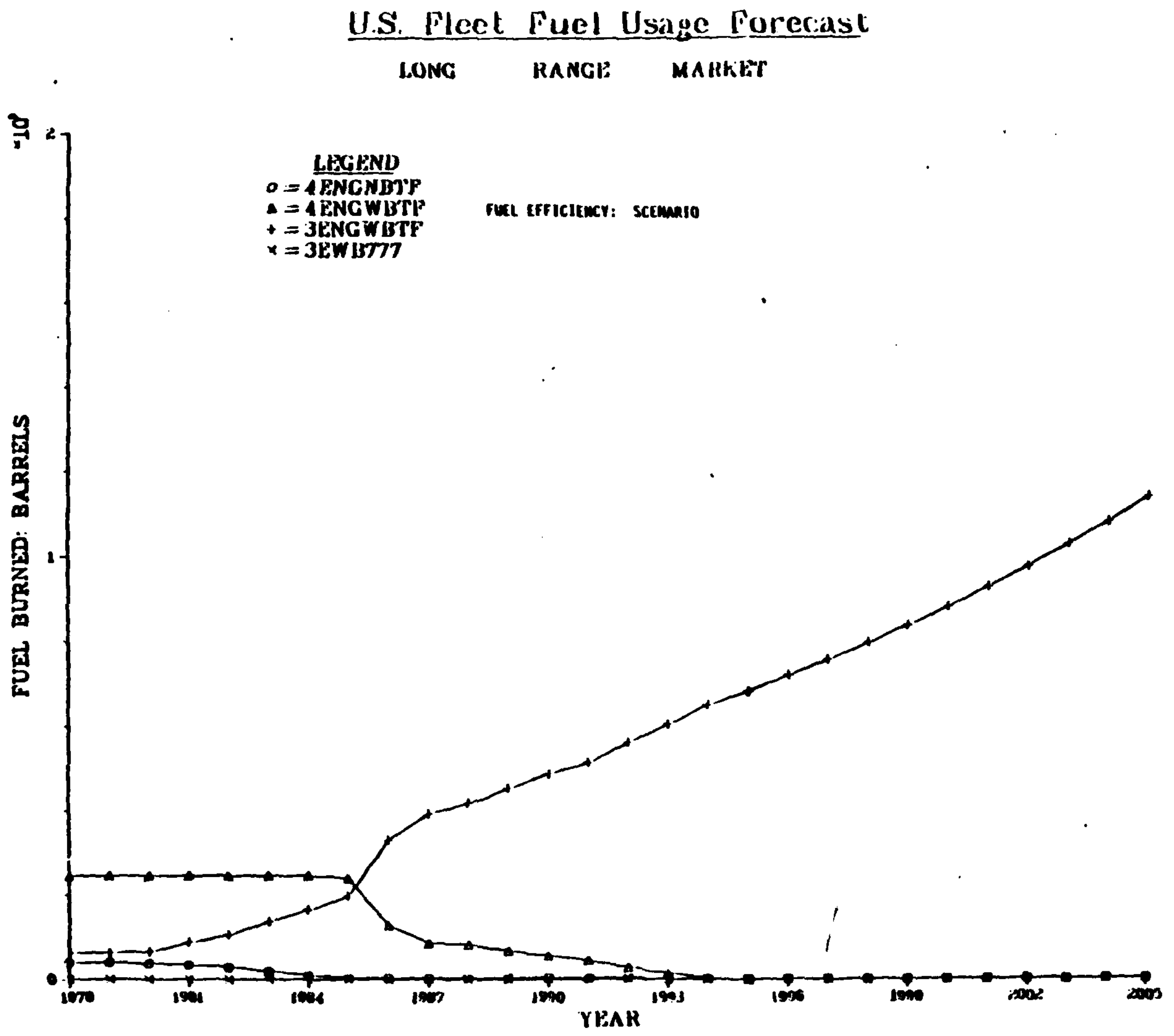
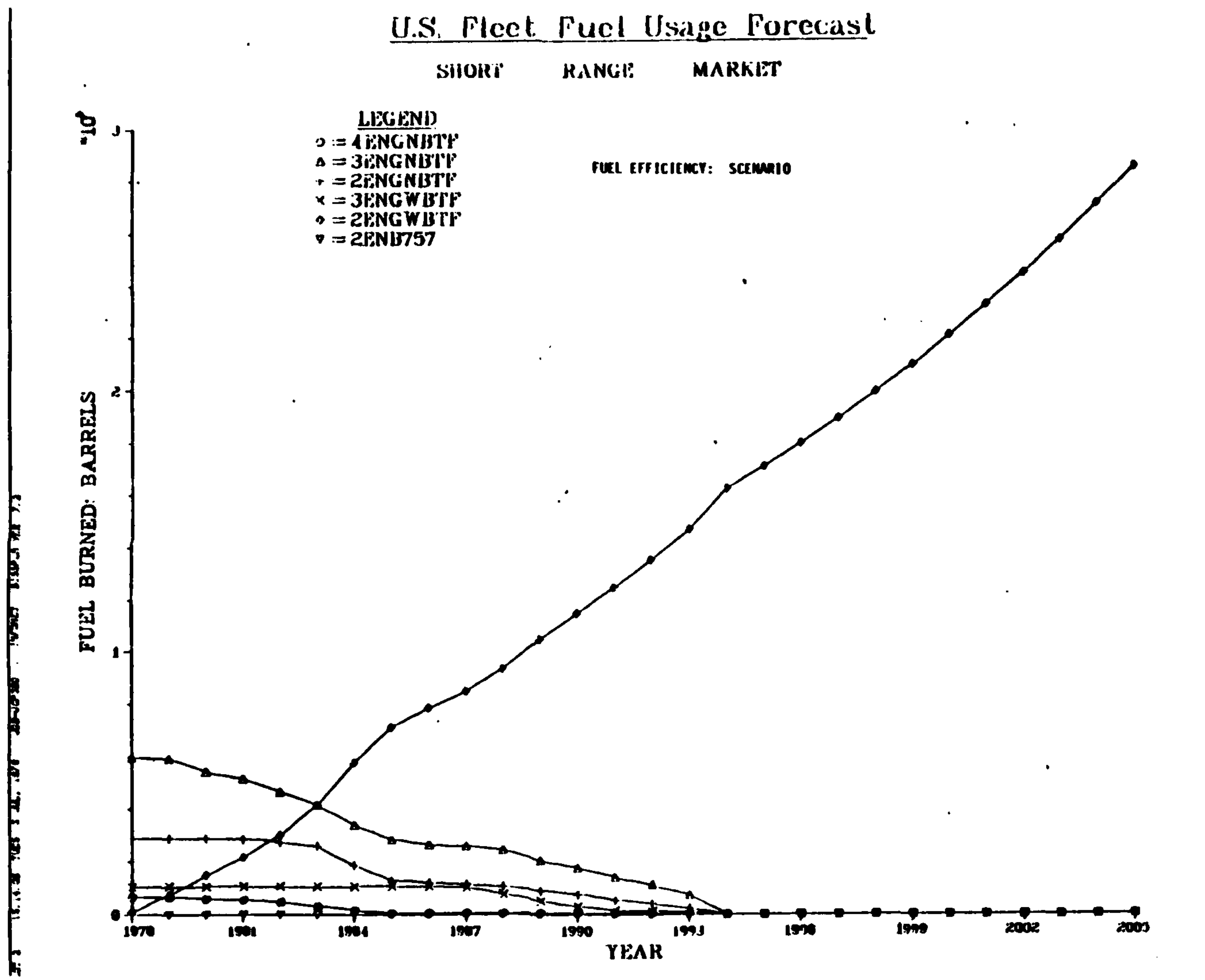

U.S. Fleet Fuel Usage Forecast
LONG RANGE MARKET
LEGEND
o = 4ENGNBTF
▲ = 4ENGWBTF
+ = 3ENGWBTF
× = 3EWB777
FUEL EFFICIENCY: SCENARIO
FUEL BURNED: BARRELS
YEAR

EXHIBIT B-1



U.S. Fleet Fuel Usage Forecast
SHORT RANGE MARKET
LEGEND
○ = 4ENGNBTF
△ = 3ENGNBTF
+ = 2ENGNBTF
× = 3ENGWBTF
◇ = 2ENGWBTF
▽ = 2ENB757
FUEL EFFICIENCY: SCENARIO
FUEL BURNED: BARRELS
YEAR

EXHIBIT B-2

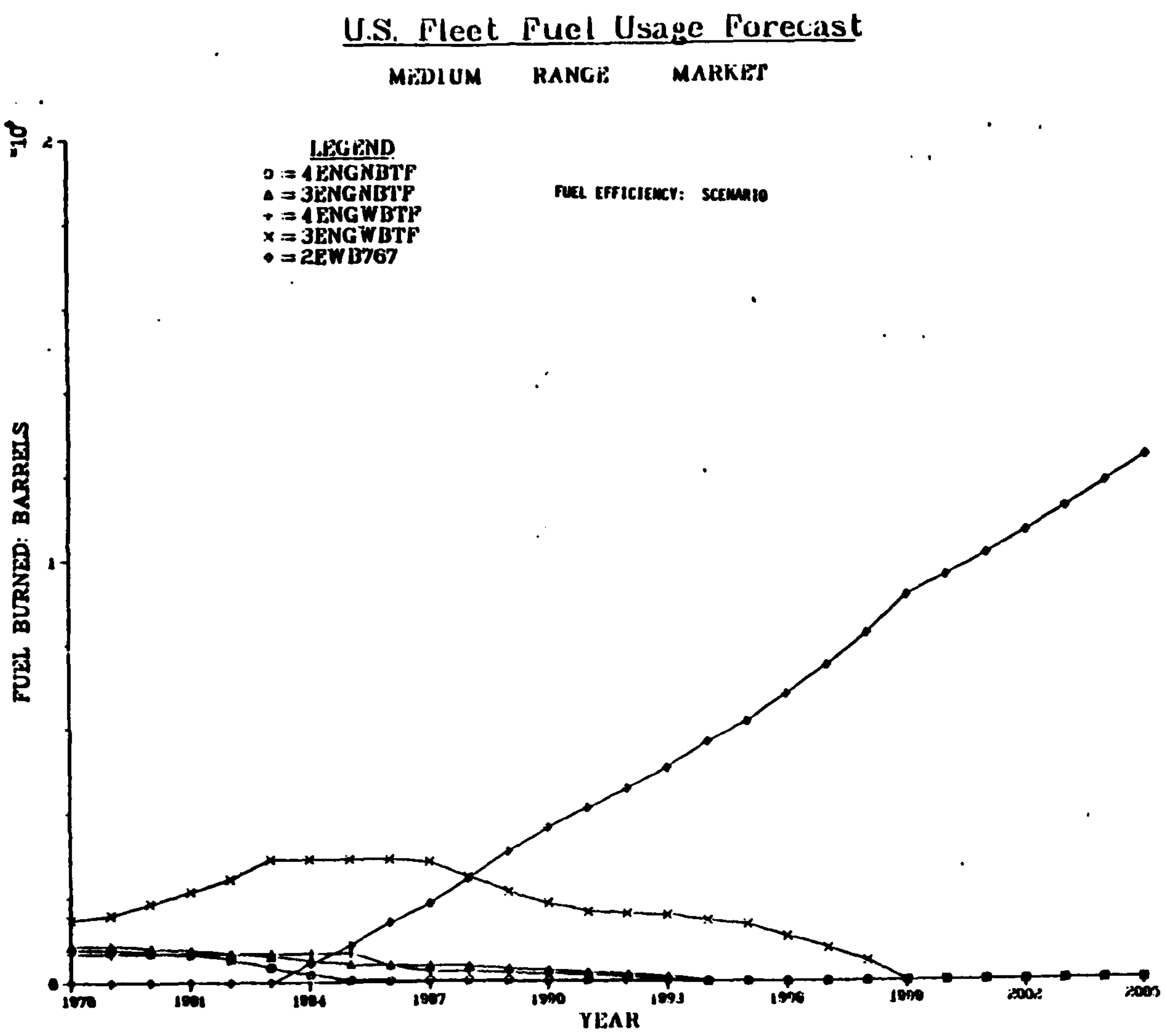

U.S. Fleet Fuel Usage Forecast
MEDIUM RANGE MARKET
LEGEND
o = 4ENGNBTF
Δ = 3ENGNBTF
+ = 4ENGWBTF
× = 3ENGWBTF
◆ = 2EWB767
FUEL EFFICIENCY: SCENARIO
FUEL BURNED: BARRELS
*10
2
1
0
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
YEAR

EXHIBIT B-3

B. DISSPL3 PROGRAM

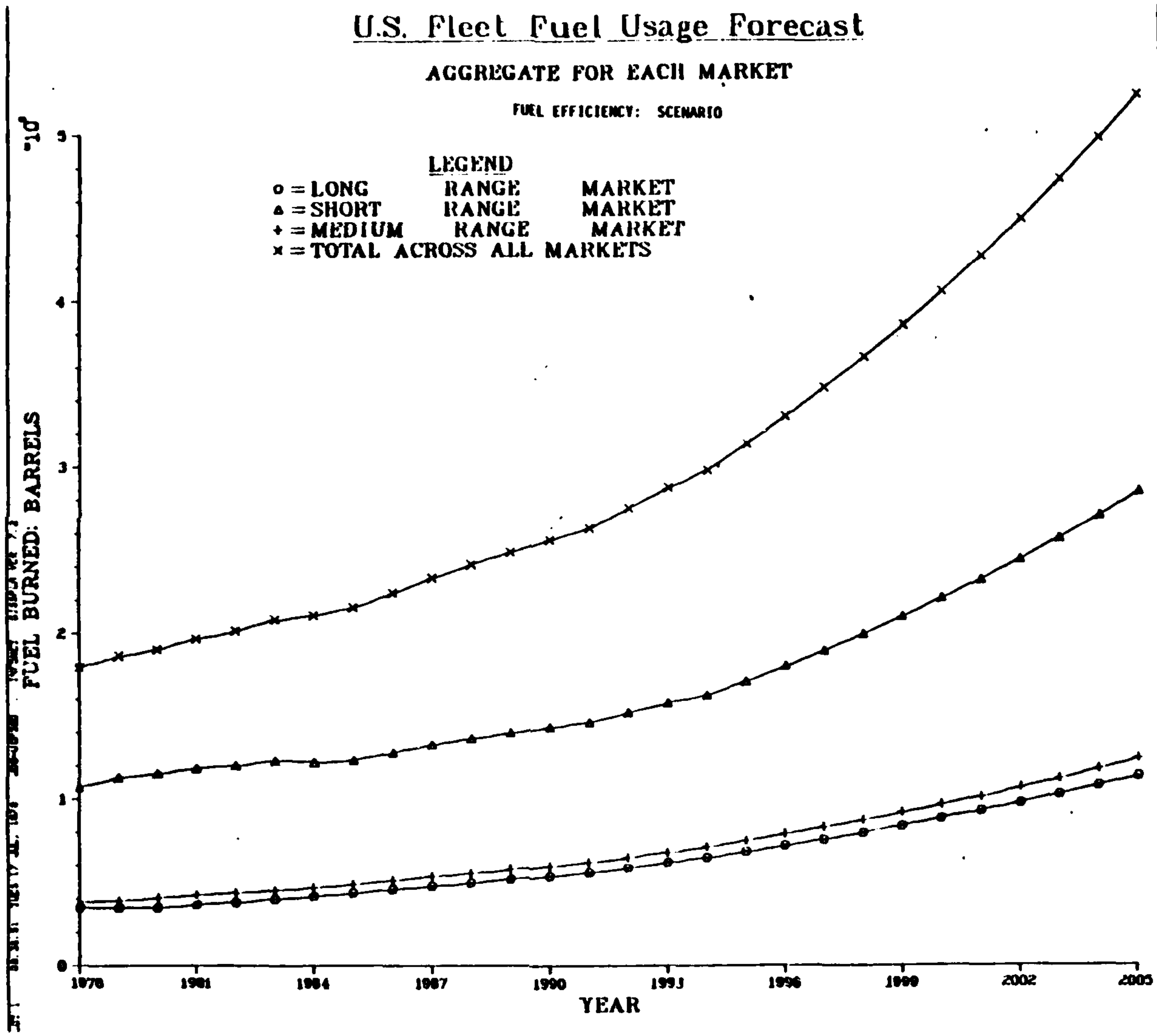
Exhibit B-4 presents a sample output from the DISSPL3 program. This graph shows millions of barrels of fuel burned, by year, for each market. In addition, it presents total fuel burned across all markets.

C. DISSPL4 PROGRAM

Exhibit B-5 presents a sample output from the DISSPL4 program. This graph shows millions of barrels of cumulative fuel burned as each aircraft enters each market. That is, the lowest curve shows fuel consumed by 4ENGNBTF aircraft in the first market considered. The next highest line shows fuel consumed by 4ENGNBTF plus fuel consumed by 4ENGWBTF in the first market. After all aircraft in the first market are cumulated, the aircraft in the second market are added to these results one-at-a-time. Finally, aircraft in the third market are considered in the same manner. The uppermost curve corresponds to the total across all markets.

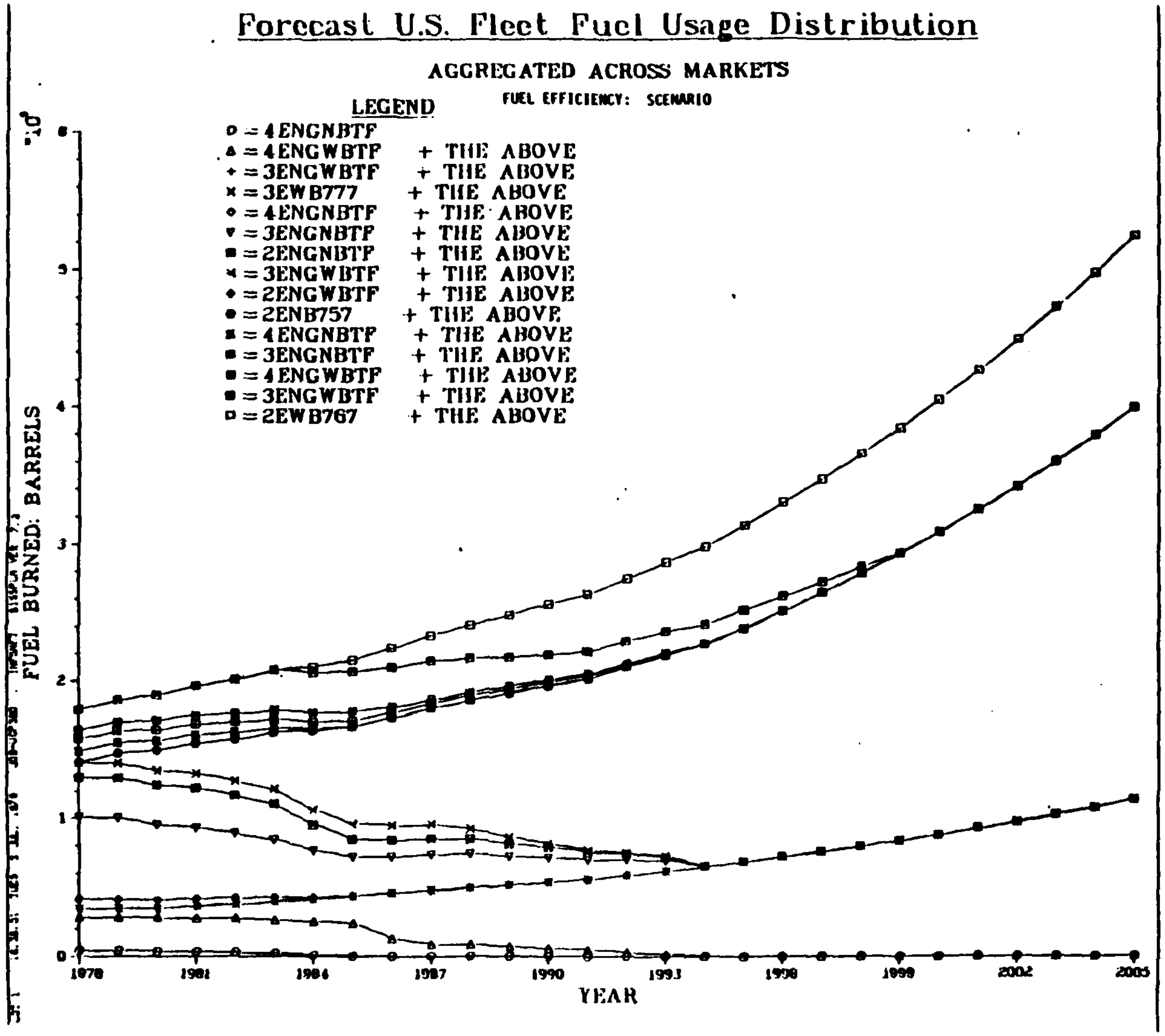
D. GRAPHICS PROGRAM EXECUTION

As shown in the Introduction to Volume II, each of the graphics programs are executed using the appropriate EQUATE, LINK, execute, and DISSPOP statements. The relevant input data sets/files for the graphics programs are specified via the EQUATE command. The user defined file name associated with the EQUATE 16 command is used by DISSPL2; EQUATE 18 is used by DISSPL3; and EQUTE 17 serves as the



U.S. Fleet Fuel Usage Forecast
AGGREGATE FOR EACH MARKET
FUEL EFFICIENCY: SCENARIO
LEGEND
o = LONG RANGE MARKET
Δ = SHORT RANGE MARKET
+ = MEDIUM RANGE MARKET
x = TOTAL ACROSS ALL MARKETS
*10^8
FUEL BURNED: BARRELS
0
1
2
3
4
5
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
YEAR

EXHIBIT B-4



Forecast U.S. Fleet Fuel Usage Distribution
AGGREGATED ACROSS MARKETS
FUEL EFFICIENCY: SCENARIO
LEGEND
= 4ENGNBTF
= 4ENGWBTF + THE ABOVE
= 3ENGWBTF + THE ABOVE
= 3EWB777 + THE ABOVE
= 4ENGNBTF + THE ABOVE
= 3ENGNBTF + THE ABOVE
= 2ENGNBTF + THE ABOVE
= 3ENGWBTF + THE ABOVE
= 2ENGWBTF + THE ABOVE
= 2ENB757 + THE ABOVE
= 4ENGNBTF + THE ABOVE
= 3ENGNBTF + THE ABOVE
= 4ENGWBTF + THE ABOVE
= 3ENGWBTF + THE ABOVE
= 2EWB767 + THE ABOVE
FUEL BURNED: BARRELS
0
1
2
3
4
5
6
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
YEAR

EXHIBIT B-5

input to DISSPL4. All of these files are generated by a single execution of the computer program code presented in Appendix B-1, and are "automatically" saved by the computer for future use. Thus, the user may generate any (or all) of the three types of graphics outputs desired. To generate any one of the three types of graphics results the user begins with the EQUATE 28 statement, as shown in the Introduction, and types in each of the remaining statements shown there. For example, assume the user wished to declare the output file name "PLTPL2" for the results of exercising the graphics program DISSPL2. In this case, the following statements would generate the graphics shown in Exhibits B-1, B-2 and B-3.

```
EQUATE 28 PLTPL2

LINK, HIER, MORE DISPL2

USE $DISS1, $DISS2

QUIT

DISPL2

SAVE PLTPL2

DISSPOP, ZET PLTPL2

cr
```

(the graphs are now being drawn on the pen plotter)

OFF

Note that by using the command "SAVE PLTPL2" the user saves the preprocessed plot file. Should the user ever wish to duplicate this graphic result in the future, only the following two commands would be necessary:

EQUATE 28 PLTPL2

DISSPOP, ZET PLTPL2

cr

In order to obtain the graphics results generated by DISSPL3 and/or DISSPL4 the user would repeat the above procedure instead of typing the OFF command. That is, a user declared file name would be substituted for PLTPL2 and the desired program name (DISSPL3 or DISSPL4) would be substituted for DISSPL2.

V. MODIFICATIONS

The NAFSAP computer program code presented in Appendix B-1 may be easily altered in three areas to tailor the output to user needs. These areas are: dates for the base year and the forecast ; units in which fuel burned is expressed; and factors used to disaggregate total U.S. domestic RPMs across each of the three markets. The latter area is discussed in Chapter III, Section B, the other areas are discussed below.

A. Modifications to Dates

The base year date and the date for the last forecast year are specified in the computer program code listed in Appendix B-1 and Appendix B-3. The program name and the line numbers associated with these dates are shown below:

Program Name	Line Number for Date	
	Base Year	Last Forecast Year
Appendix B-1		
BET2PR	34.01	34.02
MODS2	399.01	399.02
BUYS2	460	461
CURVES	516.001	516.002
Appendix B-3:		
DISPL2	106.012	106.013
DISPL3	4.01	4.02
DISPL4	5.01	5.02

As shown in the computer program code, the base year is always associated with the variable name "NBYR," and the last forecast year is always associated with the variable name "NEYR." Using the REVISE statement (see Introduction for further detail) for the appropriate line numbers as listed above, the values of the beginning and end dates for the output can be easily changed. The current program dimension limits allow for 31 years of output, thus the difference between the beginning and end dates plus one (i.e., (NEYR - NBYR) + 1) must be less than or equal to 31. When alterning these dates the user must ensure that the input data bases (e.g., Appendix B-2) are consistent with these dates.

B. Modification to Units

The typical unit fuel consumption input required for each aircraft type (see Chapter III disucssion) is in lbs per seat-mile. As shown in the computer program code, Appendix B-1, lines 83, 121 and 146, this measure is converted to barrels per seat-mile via division by 281.4. The user may alter these statements, substituting appropriate consersion formula, to convert the input units (lbs per seat-mile) to such measures as gal. per seat-mile or BTUs per seat-mile. So long as seat-miles remain in the denominator, the results of changing units will be consistent with other equations used in the program.

APPENDIX B-1

BET2PR (main program)

```
      DIMENSION TYPE(10),VRINTR(10),SEATS(10),SFC(10),SPEED(10),&
      UTILIZ(10),LIFTIM(10),PLOTS(10)
      DIMENSION LF(31)
      DIMENSION GROWTH(31),MARKET(31)
      DIMENSION MODATA(6),NOBUYS(10,46),NORETR(10,46)
      DIMENSION TYPEM(10),MODYR(10),MSEATS(10),MSFC(10),MSPEED(10),&
      MUTILI(10),MLIFET(10)
      DIMENSION SEATMI(10,31),FUELAR(10,31),RPM(10,31),POPUL(10,31)
      DIMENSION TOTMIS(31),TOTFLB(31),TOTRPM(31),TOTPOP(31)
      DIMENSION SHRMIS(3,31),SHRFUL(3,31),SHRRPM(3,31),SHRPOP(3,31)
      DIMENSION TOTBUY(31),TOTRTR(31)
      DIMENSION RMKTYP(3)
      DIMENSION SHRBUY(3,31),SHRETR(3,31)
      DIMENSION PLTRPM(3),PLTFUL(3)
 DIMENSION PRPM(10)
      REAL NOBUYS,NORETR,NOBYS,NORTR
 DIMENSION TOTMKT(31)
      COMMON /MARKET/ MARKET
      COMMON /STATIS/ TYPE,VRINTR,SEATS,SFC,SPEED,UTILIZ,LF,LIFTIM,&
       PLOTS
      COMMON /MODS/ TYPEM,MODYR,MSEATS,MSFC,MSPEED,MUTILI,MLIFET
      COMMON /RESULT/ SEATMI,FUELAR,RPM
      COMMON /POP/ NOBUYS,NORETR,POPUL
      COMMON /INDIXS/ NOFXPL,IN,OUT
      COMMON /SHARES/ SHRMIS,SHRFUL,SHRRPM,SHRPOP,SHRBUY,SHRETR
      COMMON /TOTALS/ SMILES,FMBNED,RPMS,POPNO,NOBYS,NORTR
      COMMON /ACCUPS/ TOTMIS,TOTFLB,TOTRPM,TOTPOP,TOTBUY,TOTRTR
      COMMON /STARTR/ NOCRVS,RMKTYP,D1,D2,PLTRPM,PLTFUL,PERCNT
 COMMON /PRONPP/ PRPM, MRKT
    CHARACTER RMKTYP*20
    CHARACTER DATMO*10
    CHARACTER TYPE*12
     CHARACTER TYPEM*10
      INTEGER YEAR,YR
      INTEGER IN,OUT
      REAL LF,LIFTIM,MARKET,MODATA
      REAL MODYR,MSEATS,MSFC,MSPEED,MUTILI,MLIFET
 NBYR=1978
 NEYR=2005
 NOBS=(NEYR-NBYR)+1
 & BASE YR.(LAST YR. OF HISTORY) PLUS & MINUS ONE
 NBYRP1=NBYR+1
 NBYRM1=NBYR-1
```

```
      LUN=9
      LUNII=11
      REWIND LUN
      REWIND LUNII
      CALL UNITO4
      NOCRVS=0
      MRKT=1
      GO TO 96
 95   CONTINUE
      MRKT=MRKT+1
 96 CONTINUE
* FOLLOW. STOPS READS AT MAX=3 MARKETS. I.E.,=DIMENSION
      IF(MRKT .GT. 3)GO TO 999
* SET LONG, MEDIUM, SHORT MKT. FACTOR(9/78 TO 9/79 DATA) FOR TOT. MKT. SEGMENTED IN LOOP 60002
      FLONG=.214
      FMED=.245
      FSHORT=.540
      IF(MRKT .EQ. 1)FACT=FLONG
      IF(MRKT .EQ. 2)FACT=FSHORT
      IF(MRKT .EQ. 3)FACT=FMED
      READ(5,8)MRKTYP(MRKT)
 8    FORMAT (A20)
 94   CONTINUE
      WRITE (6,7) MRKTYP(MRKT)
 7    FORMAT (1H1,T50,'MARKET = ',A20)
      READ(5,1)GROWTH
 1    FORMAT (F10.0)
 97   CONTINUE
      WRITE (6,11)
 11   FORMAT(1H0,'GROWTH')
      WRITE (6,5) GROWTH
 5    FORMAT(1X,4F13.4)
      PERCNT=GROWTH(1)
      READ(5,1)LF
 93   CONTINUE
      WRITE (6,13)
 13   FORMAT(1H0,' LF ')
      WRITE (6,5) LF
*
*     READ IN STATISTICS ABOUT EXISTING AIRCRAFT CURRENTLY IN SERVICE
*
      READ(5,2)NOEXPL
 2    FORMAT(I5)
 98   CONTINUE
      WRITE (6,12)
 12   FORMAT(' EXISTING FLEET ')
```

```
      WRITE (6,2) NOEXPL
C READ DOMESTIC MARKET RPPS(I=1=1976), AVP-120 FORECAST
      DO 60002 I=1,NOHS
      READ(3,60001)TOTMKT(I)
60001 FORMAT(F5.1)
C RPMS READ IN BILLIONS, CONVERT TO UNITS AS PER PMG. REQ.
      TOTMKT(I)=TOTMKT(I)*(10.**9)
C SEGMENT TOT. RPPS TO CURRENTLY CONSIDERED MKT. USING APPROP. FACTOR
      MARKET(I)=TOTMKT(I)*FACT
60002 CONTINUE
      REWIND 3
      DO 10 I=1,NOEXPL
      READ (5,3) TYPE(I),YRINTR(I),SEATS(I),SFC(I),SPEED(I),UTILIZ(I),&
                 LIFTIM(I),PRPM(I)
    3 FORMAT(A10,6F10.0,2X,F4.3)
   99 CONTINUE
      WRITE (6,6) TYPE(I),YRINTR(I),SEATS(I),SFC(I),SPEED(I),&
                 LIFTIM(I),PRPM(I)
    6 FORMAT(1X,A10,6F10.4,2X,F4.3)
      SFC(I)=SFC(I)/281.4
C
C     READ IN PAST 15 YEAR HISTORY OF EXISTING AIRCRAFT
C
      READ (5,4) (NOBUYS(I,J),J=1,16,1)
    4 FORMAT(16I3.0)
  101 CONTINUE
      WRITE (6,5) (NOBUYS(I,J),J=1,16,1)
      READ (5,4) (NORETR(I,J),J=1,16,1)
    9 CONTINUE
      WRITE (6,5) (NORETR(I,J),J=1,16,1)
   10 CONTINUE
      DO 27 I=1,1,1
      TYPEP(I)=10HAAAAAAAAAA
   27 CONTINUE
      READ (5,2) NOPODS
  102 CONTINUE
      WRITE (6,26)
   26 FORMAT(' MODIFICATIONS ')
      WRITE (6,2) NOPODS
      IF (NOPODS.EQ.0)  GO TO 35
      DO 33 J=1,NOPODS
      READ (5,3) DATMO,MEDATA
  103 CONTINUE
      WRITE (6,6) DATMO,MODATA
      DO 26 I=1,NOEXPL
C FOLLOW. IS FUNCTION COMPARING CHARA. STRINGS IN ARRAYS(SEE TECH. NOTE
C 8841), 1ST ARG OF CHARA. COMPARED; NEXT =BEGIN. COL. COMPARE
      IV=KMPR(7,TYPE(I),2,DATMO,2)
C ZERO IS RET. TO IV IF CHARA. NAMES ARE EQUAL
      IF(IV.EQ.0) GO TO 20
      II=1
      GO TO 25
   20 CONTINUE
   25 CONTINUE
```

```
      TYPEM  (II)=DATMO
      MODYP  (II)=MODATA(1)
      MSEATS (II)=MODATA(2)
      MSFC   (II)=MODATA(3)/281.4
      MSPEED (II)=MODATA(4)
      MUTILI(II)=MODATA(6)
      MLIFET (II)=MODATA(7)
   33 CONTINUE
   35 CONTINUE
*
*     READ IN STATISTICS ABOUT NEW AIRCRAFT TO BE ENTERED INTO SERVICE
*     AT A LATER DATE.
*
      OUT=NOEXPL
      READ (5,2) NONEW
   37 CONTINUE
      WRITE (6,41)
   41 FORMAT(' NEW AIRCRAFT TYPES ')
      WRITE (6,2) NONEW
      IN=NOEXPL+1
      OUT=NOEXPL+NONEW
      IF (NONEW.EQ.0)  GO TO 45
      DO 40 I=IN,OUT,1
      READ (5,3) TYPE(I),YRINTR(I),SEATS(I),SFC(I),SPEED(I),UTILIZ(I),&
                 LIFTIM(I),PRPM(I)
  108 CONTINUE
      WRITE (6,6) TYPE(I),YRINTR(I),SEATS(I),SFC(I),SPEED(I),&
                 LIFTIM(I),PRPM(I)
      SFC(I)=SFC(I)/281.4
      DO 38 J=1,16
      NOBUYS(I,J)=0.0
      NORETR(I,J)=0.0
   38 CONTINUE
   40 CONTINUE
   45 CONTINUE
*
*     ALL STATISTICS HAVE BEEN INPUTTED IN AT THIS POINT
*
*     WE ASSUME BASE YEAR AS 1976 AND PROCEED TO COMPUTE A MARKET FOR
*     EVERY YEAR THEREAFTER BY ASSUMING A GROWTH RATE AS GIVEN.
*
      DO 55 I=1,NOEXPL
      POPUL(I,1)=0.0
      DO 55 J=1,16,1
      POPUL(I,1)=POPUL(I,1)+NOBUYS(I,J)-NORETR(I,J)
   55 CONTINUE
*
*     COMPUTE SEAT-MILES/YR/PLANE, REVENUE-PASSENGER MILES/YR/PLANE
*     AND FUEL-BURNED/YR/PLANE FOR BASE YEAR 1976.
*
      DO 56 I=1,NOEXPL
      SEATMI(I,1)=SPEED(I)*UTILIZ(I)*SEATS(I)
      RPM(I,1)=SEATMI(I,1)*LF(I)
      FUELBC(I,1)=SFC(I)*SEATMI(I,1)
```

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```
57     CONTINUE
*
*      COMPUTE RPMS GENERATED FOR BASE YEAR 1974
*
       DO 57 I=IN,OUT,1
       POPUL(I,1)=0.0
57     CONTINUE
       WRITE (6,71)
71 FORMAT(' MARKET RPMS AS DISAGGREGATED FROM AVP TOTAL DOMESTIC RPMS')
       WRITE (6,72) MARKET
72     FORMAT(1X,6F30.2)
*
*      WE NOW PROCEED TO DETERMINE THE NUMBER OF AIRCRAFT SUPPORTED BY
*      THE ASSUMED RPMS FOR THE MARKET
*
       DO 201 YEAR=NMYRP1,MEYR,1
       YR=YEAR-NMYRM1
*
*      ADJUST POPULATION OF EXISTING AIRCRAFTS ACCORDING TO THEIR
*      LIFE-CYCLE
*
       CALL ARONIZ (YR)
*
*      CHECK FOR WHETHER MODIFICATION ARE TO BE MADE TO ANY EXISTING
*      AIRCRAFT TYPES
*
       CALL MODS2 (YR)
*
*      COMPUTE RPM SHARE FOR EXISTING AIRCRAFT TYPES
*
       CALL MOYS2 (YR)
*
201    CONTINUE
* WRITE REVISED INPUT DATA(I.E., USING PRESET MARKET RPMS--SEGMENTED USING FACTORS ON AVP TOT. DOM. RPMS)
WRITE(6,60005)
60005 FORMAT(80('*'))
WRITE(6,60006)
60006 FORMAT(1H1,20X,'***** SUMMARY DESCRIPTION OF INPUT DATA (PER TYPE OF PLANE) *****')
WRITE(6,60039)
60039 FORMAT(//,7X,'TYPE',6X,'YRINTR',5X,'SEATS',7X,'SFC',5X,'SPEED',2X,'  UTILIZ',4X,'LIFTIM')
DO 60007 I=1,OUT
WRITE(6,60040)TYPE(I),YRINTR(I),SEATS(I),SFC(I),SPEED(I),UTILIZ(I),LIFTIM(I)
60040 FORMAT(/,1X,A10,6F10.4)
60007 CONTINUE
WRITE(6,60005)
       DO 401 I=1,OUT,1
       WRITE (6,201) TYPE(I)
201    FORMAT(1H1,T55,' AIRCRAFT TYPE = ',A10)
       WRITE (6,299)
299    FORMAT(1H0,' YEAR ',T12,'SEAT-MILES',T40,'FUEL BURNED',T63,
        'RPMS',T80,'POPULATION',T101,'# BUYS/YR',T120,'# RETIRED/YR')
       WRITE (6,295)
295    FORMAT(1X,T22,'(YEAR)',T42,'(YEAR)',T62,'(YEAR)',T78,'AS OF MID-YEAR',
       T99,'(THRU MID-YEAR)',T119,'(THRU MID-YEAR)'/)
```

```
      DO 300 YEAR=NHYR,NEYR,1
      YR=YEAR-NHYRP1
      SMILES=SEATMI(I,YR)*POPUL(I,YR)
      FHRNED=FUELHR(I,YR)*POPUL(I,YR)
      RPMS=RPM(I,YR)*POPUL(I,YR)
      POPNO=POPUL(I,YR)
      NOBYS=NOBUYS(I,15+YR)
      NORTR=NORETR(I,15+YR)
      WRITE (6,301) YEAR,SMILES,FHRNED,RPMS,POPNO,NOBYS,NORTR
301   FORMAT (I6,12X,5(E10.4,1X),E10.4)
      CALL SHARE (MRKT,YR)
300   CONTINUE
      CALL CURVES
* FOLLOW. WRITE FOR PLOT(DISPL4) OF AGGREG. FUEL BURN * RPM'S FOR COMPARABLE YRS.(NOT ACCUM. ACROSS YRS.) ACROSS CRAFT TYP
*NOTE: ADDIT. WRITES FOR DISLP4 ARE IN CURVES
WRITE(17,5052)TYPE(I)
5052 FORMAT(A10)
400   CONTINUE
      IF (MONEW.EQ.0)  GO TO 410
* REMOVE FOLLOW. 'GO TO' TO GET PROD. COST,* PROD.,OPT. SCHED.,ETC. FOR NEW TYPES(ADDIT. 1200 SRU'S TO USE)
GO TO 410
      CALL TYPLNT
410   CONTINUE
      PLTRPM(MRKT)=TOTRPM(NOHS)
      PLTFUL(MRKT)=TOTFLH(NOHS)
* CALL TO GET PLOT OF FUEL * RPMS FOR EACH TYPE CRAFT BY YEAR
* CALL PTSGL2 (MRKT)
* CALL DISPL1 (MRKT)
*FOLLOW. WRITES FOR PLOT(DISPL2) OF FUEL BURN * RPM'S FOR EACH TYPE OF CRAFT WITHIN EACH MARKET
WRITE(16,5022)MRKT,OLT
5022 FORMAT(2I5)
WRITE(16,5024)MRKTYP(MRKT)
5024 FORMAT(A20)
DO 2026 I=1,OUT
WRITE(16,5023)TYPE(I)
5023 FORMAT(A10)
DO 2027 YR=1,NOHS
WRITE(16,5025) FUELHR(I,YR),POPUL(I,YR),RPM(I,YR)
5025 FORMAT(3(1X,F20.2))
2027 CONTINUE
2026 CONTINUE
      DO 840 I=1,OUT,1
      SMILES =0.
      FHRNED=0.0
      RPMS   =0.0
      POPNO=0.0
      NOBYS=0
      NORTR=0
      WRITE (6,411) TYPE(I)
      WRITE (6,451)
      DO 830 YEAR=NHYR,NEYR,1
      YR=YEAR-NHYRP1
      SMILES = SMILES+SEATMI(I,YR)*POPUL(I,YR)
      FHRNED = FHRNED+FUELHR(I,Y[illegible]PUL(I,YR)
```

```
      DO 460 YEAR=NMYR,NEYR,1
      YR=YEAR-ANYRM1
      DO 460 I=1,MRKT
      SPILES = SPILES+SHRMIS(I,YR)
      FBRNED=FBRNED+SHRFUL(I,YR)
      RPMS   = RPMS  + SHRRPM(I,YR)
      BUY=BUY+SHRBUY(I,YR)
      RETIR=RETIR+SHRETR(I,YR)
  460 CONTINUE
      WRITE (6,452) YEAR, SPILES, FBRNED, RPMS, BUY, RETIR
  450 CONTINUE
      DO 600 I=1,MRKT
      WRITE (6,601) RMKTYP(I)
  601 FORMAT(1H1,T52,'MARKET = ',A20)
      WRITE (6,602)
  602 FORMAT(//T11,'YEAR',T25,'FRACTIONAL',T55,'FRACTIONAL',T85,'FRACTIONAL',&
      T115,'FRACTIONAL',          /T25,'SEAT-MILES',T55,'FUEL-BURNED',&
      T88,'RPMS',T115,'POPULATION'/)
      DO 500 YEAR=NBYR,NEYR,1
      YR=YEAR-ANYRM1
      FCTMIS = SHRMIS(I,YR)/TOTMIS(YR)
      FCTFUL = SHRFUL(I,YR)/TOTFLR(YR)
      FCTRPM = SHRRPM(I,YR)/TOTRPM(YR)
      FCTPOP = SHRPOP(I,YR)/TOTPOP(YR)
      WRITE (6,501) YEAR,FCTMIS,FCTFUL,FCTRPM,FCTPOP
  501 FORMAT(I14,4(E20.4,10X))
  500 CONTINUE
  600 CONTINUE
      DO 700 I=1,MRKT
      WRITE (6,601) RMKTYP(I)
      WRITE (6,299)
      WRITE (6,298)
      DO 650 YEAR=NMYR,NEYR,1
      YR=YEAR-ANYRM1
      WRITE (6,301) YEAR,SHRMIS(I,YR),SHRFUL(I,YR),SHRRPM(I,YR),&
                    SHRPOP(I,YR),SHRBUY(I,YR),SHRETR(I,YR)
  650 CONTINUE
  700 CONTINUE
      WRITE (6,801)
  801 FORMAT(1H1,T51,'TOTALS FOR ALL MARKETS')
      WRITE (6,299)
      WRITE (6,298)
      DO 800 YEAR=NMYR,NEYR,1
      YR=YEAR-ANYRM1
      WRITE (6,301) YEAR,TOTMIS(YR),TOTFLR(YR),TOTRPM(YR),TOTPOP(YR),&
                    TOTBUY(YR),TOTRTR(YR)
* FOLLOWS WRITE FOR PLOT(DISPLAY) OF TOTALS ACROSS ALL MARKETS
      WRITE(14,5044)TOTFLR(YR),TOTRPM(YR)
 5044 FORMAT(2(1X,F20.2))
  800 CONTINUE
      STOP
      END
```

CURVES (subroutine)

```
          SUBROUTINE CURVES
          INTEGER YRNO
          DIMENSION TOTMIS(31),TOTFLB(31),TOTRPM(31),TOTPOP(31)
          DIMENSION RPMS(30,31),FUELBR(30,31),DUMMY(21)
          DIMENSION TOTBUY(31),TOTRTR(31)
          COMMON /PLOTDA/ RPMS,FUELBR
          COMMON /ACCUMS/ TOTMIS,TOTFLB,TOTRPM,TOTPOP,TOTBUY,TOTR
TP
          COMMON /STARTR/ NOCRVS,DUMMY
          NOCRVS=NOCRVS+1
NBYR=1979
NEYR=2005
NOBS=(NEYR-NBYR)+1
% FOLLOW. WRITE FOR PLOT(DISPL4) OF AGGREG. FUEL BURN & RPM'S
FOR COMPARABLE YRS.(NOT ACCUM. ACROSS YRS.) ACROSS CRAFT TYPE & MRKT'S
% NOTE: ADDIT. WRITE FOR DISPL4 IN BETPRG, AFTER 400 CONTINUE
WRITE(17,5051)NOCRVS
5051 FORMAT(I5)
          DO 10 YRNO=1,NOBS
          RPMS   (NOCRVS,YRNO)=TOTRPM(YRNO)
          FUELBR (NOCRVS,YRNO)=TOTFLB(YRNO)
%  'LLOW. WRITE FOR PLOT(DISPL4), ADDIT. WRITE IN BETPRG
WRITE(17,5050)FUELBR(NOCRVS,YRNO),RPMS(NOCRVS,YRNO)
5050 FORMAT(2(1X,F20.2))
10        CONTINUE
          RETURN
          END
```

AMORTZ (subroutine)

```
      SUBROUTINE AMORTZ (YR)
      DIMENSION TYPE(10),YRINTR(10),SEATS(10),SFC(10),SPEED(10),&
       UTILIZ(10),LIFTIM(10)
      DIMENSION POPUL(10,31),NOBUYS(10,46),NORETR(10,46)
      DIMENSION PLOTS(10)
      DIMENSION LF(31)
      INTEGER YR,OUT,DYEAR,PASS
      REAL LF,LIFTIM,NOBUYS,NORETR
      COMMON /STATIS/ TYPE,YRINTR,SEATS,SFC,SPEED,UTILIZ,LF,LIFTIM,&
      PLOTS
      COMMON /POP/ NOBUYS,NORETR,POPUL
      COMMON /INDIXS/ NOEXPL,IN,OUT
    CHARACTER TYPE*12
      DO 5 I=1,OUT
      NOBUYS(I,15+YR)=0.0
      NORETR(I,15+YR)=0.0
5     CONTINUE
      DO 30 I=1,OUT
      DYEAR=15+YR-LIFTIM(I)
      IF (DYEAR.LE.0)  GO TO 15
      NORETR(I,15+YR)=NOBUYS(I,DYEAR)
15    CONTINUE
      POPUL(I,YR)=POPUL(I,YR-1)-NORETR(I,15+YR)
& FOLL. ST. CHG. LE 0.0 TO LE 0.001. # OF SIG. PLACES PROB.: UNIVAC VS CDC EQUIPMENT
      IF (POPUL(I,YR).LE.0.001)  POPUL(I,YR)=0.0
      IF ((POPUL(I,YR-1).EQ.0.0).AND.(POPUL(I,YR).EQ.0.0))&
         NORETR(I,15+YR)=0.0
30    CONTINUE
      RETURN
      END
```

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MODS 2 (subroutine)

```
      SUBROUTINE MODS2 (YR)
      DIMENSION TYPE(10),YRINTR(10),SEATS(10),SFC(10),SPEED(10),&
       UTILIZ(10),LIFTIM(10)
      DIMENSION LF(31)
      DIMENSION TYPEM(10),MODYR(10),MSEATS(10),MSFC(10),MSPEED(10),&
       MUTILI(10),MLIFET(10)
      DIMENSION SEATPI(10,31),FUELBR(10,31),RPM(10,31)
      DIMENSION, PLOTS(10)
DIMENSION MARKET(31),POPUL(10,31)
DIMENSION NOBUYS(10,46),NORETR(10,46)
COMMON /POP/ NOBUYS,NORETR,POPUL
COMMON /MARKET/ MARKET
REAL MARKET,NOBUYS,NORETR
      INTEGER YR,OUT
      REAL LF,LIFTIM,MODYR,MSEATS,MSFC,MSPEED,MUTILI,MLIFET
      COMMON /STATIS/ TYPE,YRINTR,SEATS,SFC,SPEED,UTILIZ,LF,LIFTIM,&
      PLOTS
      COMMON /MODS/ TYPEM,MODYR,MSEATS,MSFC,MSPEED,MUTILI,MLIFET
      COMMON /RESULT/ SEATMI,FUELBR,RPM
      COMMON /INDEXS/ NOEXPL,IN,OUT
     CHARACTER TYPEM*10,TYPE*12
MHYR=1978
NFYR=2005
NOPS=(NFYR-MHYR)+1
* BASE YR.(LAST YR. HISTORY) PLUS * MINUS ONE
MHYRP1=MHYR+1
MHYRM1=MHYR-1
      YEAR=YR+MHYRM1
      DO 200 I=1,NOEXPL
      IF (TYPEM(I).EQ.10HAAAAAAAAAA)  GO TO 200
      IF (MODYR(I).NE.YEAR)  GO TO 100
      IF (MSEATS(I).EQ.0.0)  GO TO 10
      SEATS(I)=(SEATS(I)+MSEATS(I))/2.
   10 CONTINUE
      IF (MSFC(I).EQ.0.0)  GO TO 20
      SFC(I)=(SFC(I)+MSFC(I))/2.
   20 CONTINUE
      IF (MSPEED(I).EQ.0.0)  GO TO 30
      SPEED(I)=(SPEED(I)+MSPEED(I))/2.
   30 CONTINUE
      IF (MUTILI(I).EQ.0.0)  GO TO 40
      UTILIZ(I)=(UTILIZ(I)+MUTILI(I))/2.
   40 CONTINUE
      IF (MLIFET(I).EQ.0.0)  GO TO 100
      LIFTIM(I)=(LIFTIM(I)+MLIFET(I))/2.
  100 CONTINUE
      IF (MODYR(I)+1.NE.YEAR)  GO TO 200
      IF (MSEATS(I).EQ.0.0)  GO TO 110
      SEATS(I)=MSEATS(I)
  110 CONTINUE
      IF (MSFC(I).EQ.0.0)  GO TO 120
      SFC(I)=MSFC(I)
  120 CONTINUE
      IF (MSPEED(I).EQ.0.0 )  GO TO 130
```

```
      SPEED(I)=NSPEED(I)
 130  CONTINUE
      IF (PUTIL(I).EQ.0.0)  GO TO 140
      UTILIZ(I)=PUTIL(I)
 140  CONTINUE
      IF (NLIFE(I).EQ.0.0)  GO TO 200
      LIFTIM(I)=NLIFE(I)
 200  CONTINUE
* FOLLOW. LOOP SETS FORECAST YRS. TO BASE YR. TO SFE(VIA COMPARISON IN BUYS) IF CAN MEET TARGET RPMS(MARKET)
* WITH EXISTING FLEET AT BASE YR. RPMS PER PLANE WITHIN ONE TYPE WITHIN ONE MARKET
      DO 300 I=1,OUT
SEATMI(I,YR)=SPEED(I)*UTILIZ(I)*SEATS(I)
RPM(I,YR)=SEATMI(I,YR)*LF(YR)
FUEL(M(I,YR)=SFC(I)*SEATMI(I,YR)
 300  CONTINUE
      RETURN
      END
```

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UNIT04 (subroutine)

```
      SUBROUTINE UNIT04
      DIMENSION CARD(8)
    CHARACTER CARD*10
10     CONTINUE
      READ (5,1)CARD
IF(CARD .EQ. 3HZAP)GO TO 99
20    CONTINUE
      WRITE (4,1) CARD
1     FORMAT(8A10)
      GO TO 10
99    CONTINUE
30    CONTINUE
      READ (5,1) CARD
IF(CARD .EQ. 3HZAP)GO TO 199
40    CONTINUE
      WRITE (9,1) CARD
      GO TO 30
199   CONTINUE
      REWIND 9
      REWIND 4
      RETURN
      END
```

```
      SUBROUTINE BUYS2 (YR)
      INTEGER YR,IN,OUT,YEAR
      DIMENSION TYPE(10),YRINTR(10),SEATS(10),SFC(10),SPEED(10),%
       UTILIZ(10),LIFTIM(10)
      DIMENSION LF(31)
      DIMENSION PLOTS(10)
      DIMENSION MARKET(31)
      DIMENSION NOBUYS(10,46),NORETR(10,46)
      DIMENSION SEATMI(10,31),FUELBR(10,31),RPM(10,31),POPUL(10,31)
DIMENSION INEW(10), PRPM(10),DIFTYP(10),PPRPM(10)
DIMENSION NOLD1(10),NOLD2(10),NOLD3(10),NOLD(10),INDIC(3),POLDTP(3),P
NEWTP(3)
% FOLLOW. INDEX VECTORS ARE FOR MKTS. 1,2, & 3
% SET INDEX: =1 FOR TYPE INCR.(BY POLDTP); =0 TYPE TO RECIEVE EQUALLY
 DISTRIBUTED DECREASE; =2 SPECIAL CASE, SEE BELOW
% IF INDEX=2, THE TOTAL AMT. OF DECR.(CORRESP. TO POLDTP*# OF PLANES
INCR.) WILL BE APPLIED TO THAT TYPE OF PLANE(EQUALLY DIVIDED IF GT 1)
% IF NO INDEX EQ 2(I.E., INDEX=1 OR =0)  THEN DECR. IS EQUALLY DISTRI
BUTED
%THUS IF INDEX=2 FOR ANY TYPE WITHIN A MKT., THE TYPE WHERE INDEX=1 A
RE INCREASED., THE TYPE(S) WHERE INDEX=2 GET ALL THE CORRESP. DECR., &
% THE TYPES WHERE INDEX=0 ARE IGNORED(I.E., THEIR READ IN PRPM VAL. I
S RETAINED CONSTANT)
% NOTE: ALWAYS SET INDEX FOR NEW TYPE=1
DATA (NOLD1(I),I=1,7) /2,2,2,0,1,1,1/
DATA (NOLD2(I),I=1,7) /2,0,0,1,2,2,1/
DATA (NOLD3(I),I=1,7) /2,0,1,2,2,1,1/
% SET PROP. INCR. APPLIED TO EXISTING TYPES(AS DESIGNATED BY NOLD=1,
ABOVE) BY MKT.
DATA (POLDTP(I),I=1,3) /.04,.02,.04/
% SET PROP. INCR. APPLIED TO NEW TYPES BY MKT.
DATA (PNEWTP(I),I=1,3) /.03,.03,.03/
% SET TYPE OF ANALYSIS FOR EACH MKT.: INDIC=2 IS FUEL EFFICIENCY;
% INDIC=1 IS OWN FLEET(USES NOLD,POLDTP,PNEWTP); INDIC=0 IS LAST PLAN
E READ GETS DEFICIT RPMS
DATA (INDIC(I),I=1,3) /1,1,1/
      REAL MARKET,LF,LIFTIM,LOADFC,NOBUYS,NORETR
      COMMON /STATIS/ TYPE,YRINTR,SEATS,SFC,SPEED,UTILIZ,LF,LIFTIM,%
      PLOTS
      COMMON /RESULT/ SEATMI,FUELBR,RPM
      COMMON /MARKET/ MARKET
      COMMON /INDIXS/ NOEXPL,IN,OUT
      COMMON /POP/ NOBUYS,NORETR,POPUL
COMMON /PRORPM/ PRPM,MRKT
   CHARACTER TYPE*12
NBYR=1978
NEYR=2005
NOBS=(NEYR-NBYR)+1
% BASE YR.(LAST YR. OF HISTORY) PLUS & MINUS ONE
NBYRP1=NBYR+1
NBYRM1=NBYR-1
      TOTAL=0.0
```

```
      TOTAL=0.0
      DO 100 I=1,OUT
      TOTAL=TOTAL+RPM(I,YR)*POPUL(I,YR)
100   CONTINUE
      RPMDIF=MARKET(YR)-TOTAL
      IF (RPMDIF.LT.0.0)  GO TO 999
YEAR=YR+NBYRM1
% IN FOLLOW. IF INDIC=1 USER SET PARAMETERS ON CRAFT RPM PERCENTS EFF
ECTIVE; IF INDIC=2 GET MOST FUEL EFFICIENT RESULTS
IF(INDIC(MRKT) .EQ. 1)GO TO 201
IF(INDIC(MRKT) .EQ. 2)GO TO 500
      DO 200 I=1,OUT,1
      J=OUT-I+1
      IF ((YRINTR(J).GT.YEAR).OR.(YRINTR(J).EQ.0.0))  GO TO 200
      IT=J
      GO TO 300
200   CONTINUE
      RETURN
300   CONTINUE
      NOBUYS(IT,15+YR)=RPMDIF/RPM(IT,YR)
      POPUL(IT,YR)=POPUL(IT,YR)+NOBUYS(IT,15+YR)
      IF (POPUL(IT,YR).LT.0.0)  POPUL(IT,YR)=0.0
      RETURN
201 KCOUNT=0
LCOUNT=0
ICOUNT=0
MCOUNT=0
JK=0
DO 202 I=1,OUT
INEW(I)=0
IF(YRINTR(I) .GT. NBYR)GO TO 301
GO TO 202
% ASSIGNMENT FOR NEW TYPES(AT TERM. OF LOOP 202 ONLY NEW, NOT RELEVAN
T--NOT INTRO. BY CURRENT YR.--CRAFT HAVE INEW(I)=1
301 INEW(I)=1
IF(YRINTR(I) .LE. YEAR)GO TO 302
GO TO 202
% ASSIGN. FOR NEW & RELEVANT--INTRO. IN OR AFTER CURRENT YR.--TYPES O
NLY
302 INEW(I)=2
% JK INDEX IDENTIFES NEW TYPE
JK=I
% SET COUNTER ON NEW & RELEVANT TYPES
KCOUNT=KCOUNT+1
202 CONTINUE
% CHECK IF PRPM FACTORS SUM TO APPROX. 100.0 PERCENT
NDIV=NOEXPL+KCOUNT
TFACT=0.0
DO 401 I=1,OUT
IF(INEW(I) .EQ. 0 .OR. INEW(I) .EQ. 2)TFACT=TFACT+PRPM(I)
401 CONTINUE
IF(TFACT .GE. .99 .AND. TFACT .LE. 1.01)GO TO 402
```

```
508      IF(TFACT .GE. .99 .AND. TFACT .LE. 1.01)GO TO 402
508.01   % SINCE SUM PRPM FORCED=100 FOR PREV. YRS., THEN WHEN NEW TYPE ENTERS
SUM WILL EXCEED 100, HENCE SUB. EXCESS FROM EXISTING TYPES
509      DO 403 I=1,NOEXPL
510      PRPM(I)=PRPM(I)+((1.0-TFACT)/NOEXPL)
511      403 CONTINUE
511.1    % MAKE SURE START MAX. IS FOR RELEVANT CRAFT
511.2    402 VMAX=0.0
511.3    DO 425 I=1,OUT
511.4    IF(YRINTR(I) .LE. YEAR)VMAX=PRPM(I)
511.5    IF(VMAX .GT. 0.0)GO TO 426
511.6    425 CONTINUE
512      % FIND TYPE HAVING THE MAX. PRPM VALUE FOR CURRENT MRKT.
514      426 DO 208 I=1,OUT
514.1    IF(INEW(I) .EQ. 1)GO TO 208
514.2    % MUST USE .GE. IN FOLLOW. TO ACCT. FOR CASE WHERE INITAL VMAX(LINE 5
11.4) IS MAX. & MUST GET TO 209 TO SET MCOUNT
515      IF(PRPM(I) .GE. VMAX)GO TO 209
515.01   GO TO 208
515.02   209 VMAX=PRPM(I)
515.03   MCOUNT=I
516      208 CONTINUE
516.01   IF(MRKT .NE. 1)GO TO 6017
516.02   DO 6014 I=1,OUT
516.03   WRITE(6,6015)PRPM(I),I
516.04   6015 FORMAT(1X,'CHECK START PRPM(I)=',F5.3,1X,'I=',I3)
516.05   6014 CONTINUE
516.06   WRITE(6,6018)MCOUNT,VMAX
516.07   6018 FORMAT(1X,'CHECK MCOUNT=',I3,1X,'VMAX=',F5.3)
516.08   6017 CONTINUE
520      DO 220 I=1,OUT
521      IF(MRKT .EQ. 1)NOLD(I)=NOLD1(I)
522      IF(MRKT .EQ. 2)NOLD(I)=NOLD2(I)
523      IF(MRKT .EQ. 3)NOLD(I)=NOLD3(I)
523.01   220 CONTINUE
523.02   % FOLLOW. TRANSFER MADE ONLY IF HAVE BOTH NEW & RELEVANT TYPES IN CUR
RENT MARKET & CURRENT YR.
523.03   IF(KCOUNT .GT. 0)GO TO 3
524      % MOVE INDEX DESIGNATING WHERE TYPES ARE INCR./DECR./MAX. DECR.
524.01   INCR=0
525      DO 306 I=1,NOEXPL
526      % SET COUNTER ON # CRAFT INCREMENTED
527      IF(NOLD(I) .EQ. 1)INCR=INCR+1
527.01   % INCREASE PRPM SHARE FOR DESIGNATED TYPES
527.02   IF(NOLD(I) .EQ. 1)PRPM(I)=PRPM(I)+POLDTP(MRKT)
528      306 CONTINUE
528.01   % SET # OF TYPES TO BE DECR.--USED IF DECR. IS DISTRIB. EQUALLY
529      ISTOP=NOEXPL-INCR
529.001  % CHECK CASE WHERE SOME CRAFT ARE DECR. AT MAX RATE
529.0011 IDROP=0
529.002  DO 221 I=1,NOEXPL
529.003  IF(NOLD(I) .EQ. 2)IDROP=IDROP+1
529.004  221 CONTINUE
529.005  IF(IDROP  .EQ. 0)GO TO 222
529.006  % DO CASE WHERE SOME CRAFT ARE DECR. AT MAX. RATE
529.007  DO 223 I=1,NOEXPL
529.008  IF(NOLD(I) .EQ. 2)PRPM(I)=PRPM(I)-((POLDTP(MRKT)*INCR)/IDROP)
529.009  223 CONTINUE
529.01   GO TO 207
530      222 DO 205 I=1,NOEXPL
531      % DO CASE WHERE EQUAL DECR. APPLIED TO DESIGNATED TYPES
```

```
% DO CASE WHERE EQUAL DECR. APPLIED TO DESIGNATED TYPES
IF(NOLD(I) .EQ. 0)PRPM(I)=PRPM(I)-((POLDTP(I)*INCR)/ISTOP)
IF(MRKT .EQ. 1)WRITE(6,5012)I,NOLD,PRPM(I)
5012 FORMAT(1X,'CHECK 205 I=',I3,1X,'NOLD=',I3,1X,'PRPM(I)=',F5.3)
205 CONTINUE
GO TO 207
% CHECK CASE WHERE SOME TYPES ARE DECR. AT MAX. RATE
3 IDROP=0
DO 227 I=1,OUT
IF(NOLD(I) .EQ. 2)IDROP=IDROP+1
227 CONTINUE
% FOLLOW. OP. DONE IF HAVE NEW & REL. CRAFT IN CURRENT MRKT. IN CURRE
NT YR.
% CHECK IF NEW PLANES ENTERS DURING CURRENT YEAR
DO  229 I=1,OUT
IF(YRINTR(I) .EQ. YEAR)GO TO 230
229 CONTINUE
DO 206 I=1,OUT
IF(INEW(I) .EQ. 2)PRPM(I)=PRPM(I)+PNEWTP(MRKT)
IF(IDROP .EQ. 0)GO TO 226
% DO CASE WHERE SOME TYPES ARE DECR. AT MAX. RATE
IF(NOLD(I) .EQ. 2)PRPM(I)=PRPM(I)-((PNEWTP(MRKT)*KCOUNT)/IDROP)
GO TO 206
% IF NONE DECR. AT MAX. RATE, DISTRIB. DECR. EQUALLY
226 IF(INEW(I) .EQ. 0)PRPM(I)=PRPM(I)-((PNEWTP(MRKT)*KCOUNT)/NOEXPL)
206 CONTINUE
GO TO 207
% CASE OF 1ST YR. IN FOR NEW TYPE CRAFT
230 IF(IDROP .EQ. 0)GO TO 228
% DO CASE WHERE SOME TYPES DECR. AT MAX. RATE
DO 243 I=1,OUT
IF(NOLD(I) .EQ. 2)PRPM(I)=PRPM(I)-((PRPM(JK)*KCOUNT)/IDROP)
243 CONTINUE
GO TO 207
% DO CASE TO DISTRIB. DECR. EQUALLY
228 DO 244 I=1,OUT
IF(INEW(I) .EQ. 0)PRPM(I)=PRPM(I)-((PRPM(JK)*KCOUNT)/NOEXPL)
244 CONTINUE
% CHECK TO SEE THAT NO FACTORS ARE NEG., IF NEG. RESET TO ZERO AND TA
KE NEG. FROM MAX. FACTOR
207 DO 310 I=1,OUT
IF(MRKT .EQ. 1)WRITE(6,5018)I,INEW(I),PRPM(I)
5018 FORMAT(1X,'CHECK 206 I=',I3,1X,'INEW(I)=',I3,'PRPM(I)=',F5.3)
IF(PRPM(I) .LT. 0.0)GO TO 308
GO TO 310
308 PRPM(MCOUNT)=PRPM(MCOUNT)+PRPM(I)
PRPM(I)=0.0
% SET COUNTER ON # OF ZERO FACTORS
LCOUNT=LCOUNT+1
310 CONTINUE
IF(LCOUNT .EQ. OUT)GO TO 9999
TRPMTY=0.0
TDIFTY=0.0
DO 203 I=1,OUT
PPRPM(I)=PRPM(I)
% FACTOR FOR NEW BUT NOT RELEVANT CRAFT IS SET TO ZERO
IF(INEW(I) .EQ. 1)PPRPM(I)=0.0
IF(MRKT .EQ. 1)WRITE(6,6021)PPRPM(I),I,YR
6021 FORMAT(1X,'CHECK WORKING PRPM(I)=',F5.3,1X,'I=',I3,1X,'FOR YR=',
I3)
% CHECK COMPUTE
557 TRPMTY=TRPMTY+PPRPM(I)
% DISTRIBUTE RPMDIF ACCORD. TO PROP. FACTOR
DIFTYP(I)=RPMDIF*PPRPM(I)
% CHECK COMPUTE
TDIFTY=TDIFTY+DIFTYP(I)
NOBUYS(I,15+YR)=DIFTYP(I)/RPM(I,YR)
POPUL(I,YR)=POPUL(I,YR)+NOBUYS(I,15+YR)
IF(POPUL(I,YR) .LT. 0.0)POPUL(I,YR)=0.0
```

```
564       IF(POPUL(I,YR) .LT. 0.0)POPUL(I,YR)=0.0
565       203 CONTINUE
566       % CHECK PRINT
567       IF(MRKT .EQ. 1)WRITE(6,303)YR,TRPMTY,TDIFTY,RPMDIF
568       303 FORMAT(1X,'CHECK YR=',I3,1X,'TOT PERC=',F5.3,1X,'NEXT 2 MUST BE =
',2(2X,E30.20))
569       GO TO 304
570       9999 WRITE(6,305)MRKT
571       305 FORMAT(1H ,1X,'OPTION NOT VIABLE: MAX. PRPM FACTOR TO SMALL TO AC
COMODATE SPECIFIED PERCENT INCREASE, SEE BUYS2, MRKT= ',I3)
572       STOP
573       304 CONTINUE
574       RETURN
574.001   % FIND MOST FUEL EFFICENT RELEVANT AIRCRAFT
574.002   500 JCOUNT=0
574.003   VMIN=0.0
574.0031  % MAKE SURE START. MIN. IS FOR RELEVANT CRAFT
574.004   DO 504 I=1,OUT
574.005   IF(YRINTR(I) .LE. YEAR)VMIN=SFC(I)
574.006   IF(VMIN .GT. 0.0)GO TO 506
574.007   504 CONTINUE
574.008   % FIND MOST FUEL EFFIC. RELEVANT CRAFT
574.009   506 DO 501 I=1,OUT
574.01    IF((YRINTR(I) .GT. YEAR) .OR. (YRINTR(I) .EQ. 0.0))GO TO 501
574.011   % MUST USE .LE. TO ACCT. FOR CASE WHERE INITAL VMIN(LINE 574.005) IS
MIN. AND MUST GET TO 502 TO SET JCOUNT
574.0111  IF(SFC(I) .LE. VMIN)GO TO 502
574.012   GO TO 501
574.013   % SAVE MIN. VALUE & INDICATOR FOR MIN. TYPE CRAFT
574.014   502 VMIN=SFC(I)
574.015   JCOUNT=I
574.016   501 CONTINUE
574.017   NOBUYS(JCOUNT,15+YR)=RPMDIF/RPM(JCOUNT,YR)
574.018   POPUL(JCOUNT,YR)=POPUL(JCOUNT,YR)+NOBUYS(JCOUNT,15+YR)
574.019   IF(POPUL(JCOUNT,YR) .LT. 0.0)POPUL(JCOUNT,YR)=0.0
574.02    RETURN
575       999   CONTINUE

576             LOADFC=MARKET(YR)/TOTAL

577             YEAR=YR+NBYRM1

578             WRITE (6,1) LOADFC,YEAR

579       1     FORMAT(' LF = ',F5.3,' WILL SATISFIED RPM REQUIREMENT FOR YEAR
',%
580             I5)

581             RETURN

582             END
```

SHARE (subroutine)

```
      SUBROUTINE SHARE (MRKT,YR)
      INTEGER MRKT,YR
      DIMENSION TOTMIS(31),TOTFLR(31),TOTRPM(31),TOTPOP(31)
      DIMENSION TOTAUY(31),TOTRTR(31)
      DIMENSION SHRMIS(3,31),SHRFUL(3,31),SHRRPM(3,31),SHRPOP(3,31)
      DIMENSION SHRAUY(3,31),SHRETR(3,31)
      REAL NORYS,NORTR
      COMMON /SHARES/ SHRMIS,SHRFUL,SHRRPM,SHRPOP,SHRAUY,SHRETR
      COMMON /IQTALS/ SMILES,FRANED,RPMS,POPNO,NORYS,NORTR
      COMMON /ACCUMS/ TOTMIS,TOTFLR,TOTRPM,TOTPOP,TOTAUY,TOTRTR
      SHRMIS(MRKT,YR) = SHRMIS(MRKT,YR)+SMILES
      SHRFUL(MRKT,YR) = SHRFUL(MRKT,YR)+FRANED
      SHRRPM(MRKT,YR) = SHRRPM(MRKT,YR)+RPMS
      SHRPOP(MRKT,YR) = SHRPOP(MRKT,YR)+POPNO
      SHRAUY(MRKT,YR)=SHRAUY(MRKT,YR)+NORYS
      SHRETR(MRKT,YR)=SHRETR(MRKT,YR)+NORTR
      TOTMIS(YR) = TOTMIS(YR)+SMILES
      TOTFLR(YR) = TOTFLR(YR)+FRANED
      TOTRPM(YR) = TOTRPM(YR)+RPMS
      TOTPOP(YR) = TOTPOP(YR)+POPNO
      TOTAUY(YR) = TOTAUY(YR)+NORYS
      TOTRTR(YR) = TOTRTR(YR)+NORTR
      RETURN
      END
```

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APPENDIX B-2

SAMPLE INPUT DATA BASE: BETDA5
(one new aircraft type in each market)

```
$INPUT1
 EN=2.0, MACH=0.8,
  T=45000.,
   WACS=2950., WAERO=3890., WBODY=36320.,
  WEICAD=2520., WEMP=8160., WENACC=1280., WENGS=20110.,
  WFUSYS=640., WFUTOT=4863u.,                WGROSS=265100., WHYCAD=3770.,
 WINST=670., WLG=1^570., WNACEL=11290., WPACCO=19370., WPOWER=2060.,
                WWING=40730., WPAYL=45730.,
  WHANDL=100.0, WANTIC=500.0, WAVION=2129.0, WTREVS=6993.0,
$END
$INPUT2
 ADI=0.1, AGEOI=0.1, AGEPI=0.1, CFACS=2.7, CFAERO=0.65, CFBODY=0.70,
                                CFELCD=1.80, CFEMP=1.9, CFENAC=0.40,
                CFHYCD=0.55, CFINST=0.70, CFLG=0.70, CFPACC=3.10, CFPOW=3.2,
                CFWING=0.9, CONFIG=1.0, CTJI=1.C, EASPAO=0.4, EASPAR=.4C,
 FACI=0.9, FEE=0.00, FTOI=0.10, FVSPAR=0.2, GTSPAR=0.10, ICONFG=6,
 IDATA=1, IPOWER=2, IPROD=1,
 IOPS=0, NCREW=3.0, NDATA=5, NFV=5.0, NG=1.0, NOENG=150.0,
NOENG1=500.0, NOYRS=0.75, NOYRS1=1.0,
NV=867.0, NVEH=1.0,5.0,100.0,300.0,630.0,
 PDTJI=0.10, RATE=11., RE=17.0, RT=15.0, TOCLC=1.0,
 XFASSY=0.95, XNEW=0.27,
  LEAPNP=88.18, LEANN=81.85, LEANNA=81.85,
 CFFUSY=0.10,
$END
  REDUCED ENERGY PROP-FAN (767-762)
$IN
          YEAR=1985., WE=165570., FEE=0.00, NVHF=872. , IAIRPL=3,

    WENGS=20000.,
 $END
2222222222
ZAP
7.                 1.
ZAP
LONG     RANGE
6.0      6.0      6.0      6.0      6.0      6.0      6.0      6.0
6.0      6.0      6.0      6.0      6.0      6.0      6.0      6.0
6.0      6.0      6.0      6.0      6.0      6.0      6.0      6.0
6.0      6.0      6.0      6.0      6.0      6.0      6.0      6.0
.60      .60      .60      .60      .60      .60      .60      .60
.60      .60      .60      .60      .60      .60      .60      .60
.60      .60      .60      .60      .60      .60      .60      .60
.60      .60      .60      .60      .60      .60      .60      .60
    3
$ENGNATF 1960.   150.1    .1533    405.     2759.    16.       168
        1.       3.       4.       6.       11.      10.      8.       6.
        0.       0.       0.       0.       0.       0.       1.       0.
0.       0.       0.       0.       0.       0.       0.       0.
0.       0.       0.       0.       0.       0.       0.       0.
$ENGNATF 1969.   357.4    .1301    456.     3511.    14.       630
        0.       0.       0.       0.       0.       0.       2.       42.
       14.       2.       5.       5.       3.       7.       5.       5.
0.       0.       0.       0.       0.       0.       0.       0.
```

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```
55.      0.         0.       0.       0.        0.       0.        0.       0.
56.      3ENGWATF   1931.    246.2    .1267     419.     2950.     16.      0.   102
57.                 0.       0.       0.        0.       0.        0.       0.        0.
58.                 3.       11.      11.       9.       6.        1.       1.        4.
59.      0.         0.       0.       0.        0.       0.        0.       0.
60.      0.         0.       0.       0.        0.       0.        0.       0.
61.          0
62.          1
62.01    3FWA777    1987.    210.0    .134      450.     2486.0    16.           030
63.      SHORT      RANGE
64.      6.0        6.0      6.0      6.0       6.0      6.0       6.0      6.0
65.      6.0        6.0      6.0      6.0       6.0      6.0       6.0      6.0
66.      6.0        6.0      6.0      6.0       6.0      6.0       6.0      6.0
67.      6.0        6.0      6.0      6.0       6.0      6.0       6.0      6.0
68.      .60        .60      .60      .60       .60      .60       .60      .60
69.      .60        .60      .60      .60       .60      .60       .60      .60
70.      .60        .60      .60      .60       .60      .60       .60      .60
71.      .60        .60      .60      .60       .60      .60       .60      .60
72.          5
73.      4ENGWATF   1960.    150.1    .1914     405.     2759.     16.           081
74.                 1.       4.       5.        7.       15.       13.      10.       1.
75.                 0.       0.       0.        0.       0.        0.       1.        1.
76.      0.         0.       0.       0.        0.       0.        0.       0.
77.      0.         0.       0.       0.        0.       0.        0.       0.
78.      3ENGWATF   1963.    117.9    .1836     359.     2752.     16.           549
79.                 5.       62.      37.       46.      66.       101.     76.       25.
80.                 6.       20.      52.       35.      46.       40.      49.       97.
81.      0.         0.       0.       0.        0.       0.        0.       0.
82.      0.         0.       0.       0.        0.       0.        0.       0.
83.      2ENGWATF   1965.    90.5     .2127     312.     2448.     16.           234
84.                 0.       0.       6.        21.      31.       143.     109.      14.
85.                 13.      16.      29.       27.      41.       27.      29.       47.
86.      0.         0.       0.       0.        0.       0.        0.       0.
87.      0.         0.       0.       0.        0.       0.        0.       0.
88.      3ENGWATF   1971.    246.2    .1373     419.     2950.     16.           115
89.                 0.       0.       0.        0.       0.        0.       0.        0.
90.                 4.       17.      17.       14.      10.       2.       2.        6.
91.      0.         0.       0.       0.        0.       0.        0.       0.
92.      0.         0.       0.       0.        0.       0.        0.       0.
93.      2ENGWATF   1977.    240.0    .1259     360.     2752.0    16.           015
94.                 0.       0.       0.        0.       0.        0.       0.        0.
95.                 0.       0.       0.        0.       0.        0.       5.        3.
96.      0.         0.       0.       0.        0.       0.        0.       0.
97.      0.         0.       0.       0.        0.       0.        0.       0.
98.          0
99.          1
99.01    2FWA757    1982.    150.0    .147      300.     1987.0    16.           030
100.     MEDIUM     RANGE
101.     6.0        6.0      6.0      6.0       6.0      6.0       6.0      6.0
102.     6.0        6.0      6.0      6.0       6.0      6.0       6.0      6.0
103.     6.0        6.0      6.0      6.0       6.0      6.0       6.0      6.0
104.     6.0        6.0      6.0      6.0       6.0      6.0       6.0      6.0
105.     .60        .60      .60      .60       .60      .60       .60      .60
106.     .60        .60      .60      .60       .60      .60       .60      .60
```

```
107.   .60          .60          .60          .60          .60          .60          .60          .60
108.   .60          .60          .60          .60          .60          .60          .60
109.      4
110.   4ENGMPTF  1960.        150.1        .1530        405.         2759.        16.               279
111.             2.        5.           7.           11.          22.          19.          15.          1.
112.             0.        0.           0.           0.           0.           0.           2.           1.
113.   0.           0.           0.           0.           0.           0.           0.           0.
114.   0.           0.           0.           0.           0.           0.           0.           0.
115.   3ENGKRTF  1963.4       117.9        .1547        359.         2752.        16.               199
116.             1.        11.          6.           11.          11.          18.          13.          4.
117.             1.        3.           9.           6.           8.           7.           9.           17.
118.   0.           0.           0.           0.           0.           0.           0.           0.
119.   0.           0.           0.           0.           0.           0.           0.           0.
120.   4ENGWWTF  1969.        357.4        .1269        456.         3511.        16.               136
121.             0.        0.           0.           0.           0.           0.           0.           12.
122.             5.        0.           1.           1.           1.           2.           2.           2.
123.   0.           0.           0.           0.           0.           0.           0.           0.
124.   0.           0.           0.           0.           0.           0.           0.           0.
125.   3ENGWRTF  1971.        246.2        .1236        419.         2950.        16.               386
126.             0.        0.           0.           0.           0.           0.           0.           0.
127.             6.        27.          26.          21.          15.          3.           3.           10.
128.   0.           0.           0.           0.           0.           0.           0.           0.
129.   0.           0.           0.           0.           0.           0.           0.           0.
130.     0
131.      1
132.   2EWB767   1984.        200.0        .121         360.         2920.0       16.               030
```

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U. S. DOMESTIC FLEET RPSs: DOMRPM

1.	1768
2.	1969
3.	2069
4.	2178
5.	2274
6.	2415
7.	2542
8.	2674
9.	2811
10.	2943
11.	3065
12.	3195
13.	3325
14.	3451
15.	3633
16.	3825
17.	4027
18.	4239
19.	4463
20.	4699
21.	4947
22.	5208
23.	5483
24.	5773
25.	6077
26.	6398
27.	6736
28.	7091

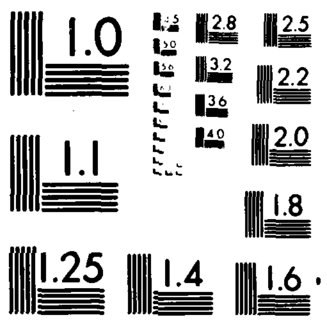
APPENDIX B-3

AD-A084 235 FEDERAL AVIATION ADMINISTRATION WASHINGTON DC OFFICE --ETC F/G 1/3
NATIONAL AVIATION FUEL SCENARIO ANALYSIS PROGRAM (NAFSAP). VOLU--ETC(U)
MAR 80 S G VAHOVICH

UNCLASSIFIED FAA/EE-80-12 NL

2 of 2

END
DATE
FILMED
6 80
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

GRAPHICS PROGRAM: DISPL2

```
* PLOTS YR. BY YR. FUEL CONSUMED & HRS BY CRAFT TYPE WITHIN EACH MRKT
      DIMENSION FUELHR(10,31),RPM(10,31),POPUL(10,31)
      DIMENSION YEARS(33),FHRMED(33),RPMS(33)
DIMENSION ITYPE(33),FULSTR(31),FULINC(31),RPMSTR(31),RPMINC(31)
DIMENSION CURV1(15,33),CURV2(15,33)
DIMENSION MRKTYP(15),ITITLE(45)
      INTEGER IN,OUT,YR,YEAR,YRAO
CHARACTER MRKTYP*30,ITYPE*12
CHARACTER IDTYP*12,IDMRKT*30
ANYR=1978
REYR=2005
NORS=(REYR-ANYR)+1
ICOUNT=0
99 ICOUNT=ICOUNT+1
IF(ICOUNT .GT. 3)GO TO 999
READ(IN,5022)MRKT,OUT
5022 FORMAT(2I5)
READ(IN,1024)MRKTYP(MRKT)
1024 FORMAT(A25)
* APPEND MARKET
SUBSTR(MRKTYP(MRKT),21,6)=AMMARKET
DO 2026 I=1,OUT
READ(IN,5023)ITYPE(I)
* AND * AT END OF EACH CRAFT TYPE, REQ. BY CALL LINES
SUBSTR(ITYPE(I),12,1)=1H*
5023 FORMAT(A12)
DO 2027 YR=1,NORS
READ(IN,5025) FUELHR(I,YR),POPUL(I,YR),RPM(I,YR)
5025 FORMAT(3(1X,F20.2))
2027 CONTINUE
2026 CONTINUE
      IUNIT=11
      DO 10 YRAO=1,NORS
YEAR=(ANYR-1)+YRAO
      YEARS(YRAO)=YEAR
10    CONTINUE
DO 200 I=1,OUT
DO 100 YEAR=ANYR,REYR
YR=YEAR-(ANYR-1)
FHRMED(YR)=FUELHR(I,YR)*POPUL(I,YR)
CURV1(I,YR)=FHRMED(YR)
RPMS(YR)=RPM(I,YR)*POPUL(I,YR)
CURV2(I,YR)=RPMS(YR)
FULSTR(YR)=FHRMED(YR)
RPMSTR(YR)=RPMS(YR)
FULINC(YR)=FHRMED(YR)
RPMINC(YR)=RPMS(YR)
100 CONTINUE
* FIND MIN. FOR START VALUES WITHIN EACH CRAFT TYPE
FMINS=FULSTR(1)
RMINS=RPMSTR(1)
DO 110 J=2,NORS
IF(FMINS .GT. FULSTR(J))FMINS=FULSTR(J)
IF(RMINS .GT. RPMSTR(J))RMINS=RPMSTR(J)
```

```
391 CONTINUE
* FIND MAX. FOR INCREASE
FMAX=FULINC(1)
NMAX=RPMINC(1)
DO 302 J=2,NOBS
IF(FMAX .LT. FULINC(J))FMAX=FULINC(J)
IF(NMAX .LT. RPMINC(J))NMAX=RPMINC(J)
302 CONTINUE
CURV1(I,NOBS+1)=FMIN
CURV2(I,NOBS+1)=NMIN
CURV1(I,NOBS+2)=FMAX
CURV2(I,NOBS+2)=NMAX
290 CONTINUE
* FIND SUPER MAX OF MAX & SUPER MIN OF MIN ACROSS CRAFT TYPES WITHIN ONE MAKT
SFMAX=CURV1(1,NOBS+2)
SRMAX=CURV2(1,NOBS+2)
SFMIN=CURV1(1,NOBS+1)
SRMIN=CURV2(1,NOBS+1)
DO 306 I=1,NUT
SFMAX=AMAX1(SFMAX,CURV1(I,NOBS+2))
SRMAX=AMAX1(SRMAX,CURV2(I,NOBS+2))
SFMIN=AMIN1(SFMIN,CURV1(I,NOBS+1))
SRMIN=AMIN1(SRMIN,CURV2(I,NOBS+1))
306 CONTINUE
* FIND ROUND WHOLE NUMBER IN APPROPRIATE UNITS FOR STEP, & MAX & MIN
* E.G.,FYRANG=2500
FYRANG=SFMAX-SFMIN
RYRANG=SRMAX-SRMIN
* E.G., ALOG(FYRANG)=X=2.4, THEN AINT(X)=3.0,& FYSTEP=1000
FYSTEP=10.**AINT(ALOG10(FYRANG))
RYSTEP=10.**AINT(ALOG10(RYRANG))
* E.G., THEN FYMAX=3000
FYMAX=FYSTEP*(1.0+AINT(FYRANG/FYSTEP))
RYMAX=RYSTEP*(1.0+AINT(RYRANG/RYSTEP))
FYMIN=FYSTEP*AINT(SFMIN/FYSTEP)
RYMIN=RYSTEP*AINT(SRMIN/RYSTEP)
YRMAX=AINT(YEARS(NOBS))
YRMIN=AINT(YEARS(1))
* FOLLOW. COMPUTE IDENTITIES ETC. FOR START OF [illegible]
ILOC=[illegible]
CALL [illegible]
CALL PAGE(11.?,11.0)
CALL [illegible]
CALL GOTHIC
CALL BASALF('L/CSTD')
CALL MIXALF('STANDARD')
CALL XTICKS(5)
CALL TITLE(IH [illegible])
CALL HEADIN('[illegible] FUEL [illegible] (FORECAST)',[illegible])
CALL [illegible]
CALL BASALF('STANDARD')
[illegible]
CALL HEADIN([illegible])
CALL [illegible]
```

```
      CALL GRAF(XMIN,3.0,YMAX,FYMIN,FYSTEP,FYMAX)
      X1=2.0
      Y1=7.75
      IPAU=INDEX(ITITL,82,1,2)
      DO 11 I=1,NUT
      DO 12 YR=1,NOBS
      FNORFQ(YR)=CURV1(I,YR)
   12 CONTINUE
      CALL MARKER(1)
      CALL CURVE(YEARS,FNORFQ,NOBS,1)
C FOLLOW. COMPUTE IDENTIFIES LOC. FOR START OF WORD
      ILOC=((I-1)*12/4)+1
      IDTYP=ITYPE(I)
      CALL LINES(IDTYP,ITITLE,1)
   11 CONTINUE
      CALL LEGEND(ITITLE,NUT,X1,Y1)
      CALL ENDPL(NUM1)
      GO TO 95
  999 CALL DONEPL
      STOP
      END
```

GRAPHICS PROGRAM: DISPL3

```
$ PLOTS AGGREG. FUEL BURNED & RPM'S FOR COMPARABLE YRS.(NOT ACCUM. ACROSS YRS.)ACROSS CRAFT TYPES WITHIN EACH MARKET
DIMENSION MKTTYP(4),SHRFUL(4,33),SHRRPM(4,33),YEARS(33),FBRNED(33),ITITE(132),FULSTR(33),RPMSTR(33),RPMINC(33),FULINC(33)
INTEGER YEAR,YRNO,YR
CHARACTER MKTTYP*30,IRMRKT*33
MRYR=1970
NEYR=2005
NROWS=(NEYR-MRYR)+1
READ(10,5002)NMKT
5002 FORMAT(I5)
$ NEED FOLLOW. TO READ TOTALS ACROSS MARKETS
NMKTP1=NMKT+1
MKTTYP(NMKTP1)=25HTOTAL ACROSS ALL MARKETS$
DO 2027 I=1,NMKT
READ(10,5001)MKTTYP(I)
5001 FORMAT(A25)
$ APPEND MARKET AT END OF WORD
SUBSTR(MKTTYP(I),21,7)=7HMARKET$
DO 2026 YR=1,NROWS
READ(10,5061)SHRFUL(I,YR),SHRRPM(I,YR)
5061 FORMAT(2(1X,F20.2))
2026 CONTINUE
2027 CONTINUE
$ READ TOTAL ACROSS ALL MKTS
DO 5065 YR=1,NROWS
READ(10,5064)SHRFUL(NMKTP1,YR),SHRRPM(NMKTP1,YR)
5064 FORMAT(2(1X,F20.2))
5065 CONTINUE
DO 10 YRNO=1,NROWS
YEAR=(MRYR-1)+YRNO
YEARS(YRNO)=YEAR
10 CONTINUE
DO 200 I=1,NMKTP1
DO 100 YEAR=MRYR,NEYR
YR=YEAR-(MRYR-1)
FULSTR(YR)=SHRFUL(I,YR)
FULINC(YR)=SHRFUL(I,YR)
RPMSTR(YR)=SHRRPM(I,YR)
RPMINC(YR)=SHRRPM(I,YR)
100 CONTINUE
$ FIND MIN. FOR START VALUES WITHIN EACH MARKET
FMIN=FULSTR(1)
RMIN=RPMSTR(1)
DO 301 J=2,NROWS
IF(FMIN .GT. FULSTR(J))FMIN=FULSTR(J)
IF(RMIN .GT. RPMSTR(J))RMIN=RPMSTR(J)
301 CONTINUE
$ FIND MAX. FOR INCREASE
FMAX=FULINC(1)
RMAX=RPMINC(1)
DO 302 J=2,41
IF(FMAX .LT. FULINC(J))FMAX=FULINC(J)
IF(RMAX .LT. RPMINC(J))RMAX=RPMINC(J)
302 CONTINUE
SHRFUL(I,NROWS+1)=FMIN
```

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```
      SHNRPM(I,NOBS+1)=RMIN
      SHPFUL(I,NOBS+2)=FMAX
      SHNRPM(I,NOBS+2)=RMAX
  200 CONTINUE
C FIND SUPER MAX OF MAX & SUPER MIN OF MIN ACROSS MARKETS
      SFMAX=SHPFUL(1,NOBS+2)
      SRMAX=SHNRPM(1,NOBS+2)
      SFMIN=SHPFUL(1,NOBS+1)
      SRMIN=SHNRPM(1,NOBS+1)
      DO 300 I=1,MKTPL
      SFMAX=AMAX1(SFMAX,SHPFUL(I,NOBS+2))
      SRMAX=AMAX1(SRMAX,SHNRPM(I,NOBS+2))
      SFMIN=AMIN1(SFMIN,SHPFUL(I,NOBS+1))
      SRMIN=AMIN1(SRMIN,SHNRPM(I,NOBS+1))
  300 CONTINUE
C FIND ROUND WHOLE NUMBER IN APPROPRIATE UNITS FOR STEP, & MAX & MIN
C E.G., FVRANG=2500
      FVRANG=SFMAX-SFMIN
      RVRANG=SRMAX-SRMIN
C E.G., ALOG(FVRANG)=X=2.5, THEN AINT(X)=3.0,& FVSTEP=1000
      FVSTEP=10.**AINT(ALOG10(FVRANG))
      RVSTEP=10.**AINT(ALOG10(RVRANG))
C E.G., THEN FVMAX=3000
      FVMAX=FVSTEP*(1.0+AINT(FVRANG/FVSTEP))
      RVMAX=RVSTEP*(1.0+AINT(RVRANG/RVSTEP))
      FVMIN=FVSTEP*(AINT(SFMIN/FVSTEP))
      RVMIN=RVSTEP*(AINT(SRMIN/RVSTEP))
      YRMAX=AINT(YEARS(NOBS))
      YRMIN=AINT(YEARS(1))
C FOLLOW. COMPUTE IDENTIFIES LOC. FOR START OF WORD
      IIPL=((NFWT-1)*20/4)+1
      CALL NGAPL(1)
      CALL PAGE(12.0,11.0)
      CALL NOTABS
      CALL FGTHIC
      CALL MASALF('L/CSTD')
      CALL MIXALF('STANDARD')
      CALL YTICKS(5)
      CALL TITLE(IN ,1,'YEARS',100,'FUEL NUM.FOR MARKETS',100,11.0,6.5)
      CALL HEADIN('U.S. FLEET (F)UEL (U)SAGE (F)ORECASTS',-100,3,2)
      CALL SCMPLX
      CALL MASALF('STANDARD')
      CALL HEADIN('AGGREGATE FOR EACH MARKET',100,2,2)
      CALL YAXANG(0.)
      CALL GRAF(YRMIN,3.,YRMAX,FVMIN,FVSTEP,FVMAX)
      X1=0.0
      Y1=7.25
[illegible]
      DO 11 I=1,MKTPL
      DO 12 [illegible]
[illegible]
   12 CONTINUE
      CALL [illegible]
      CALL [illegible]
```

```
[illegible] COMPUTE IDENTIFIES LOC. F[illegible]R START OF WORD
ILOC=((I-1)*12/4)+1
[illegible]
CALL [illegible]
11 CONTINUE
CALL [illegible]
CALL [illegible]
CALL DONEPL
STOP
END
```

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GRAPHICS PROGRAM: DISPL4

```
* PLOTS ACCUM. FUEL BURNED & BPMS FOR COMPARABLE YRS.(NOT ACCUP. ACROSS YRS.) ACROSS CRAFT TYPES & ACROSS MARKETS
DIMENSION FUEL(3C,33),BPMS(3C,33),ITYPE(3C),TITLE(1AC)
DIMENSION YEARS(33),[illegible](33),FULSTR(11),BPMSTR(11),FULINC(31),BPMINC(31)
INTEGER YEAR,YRND,YR
CHARACTER ITYPE*23,IDTYPE*23
[illegible]=1972
[illegible]=2.75
[illegible]=([illegible]-[illegible])+1
READ(17,5[illegible])NOCRUS
5[illegible] FORMAT(I5)
DO 2027 [illegible]=1,NOMS
READ(17,5[illegible]) (FUEL(NOCRUS,YRND),BPMS(NOCRUS,YRND))
5[illegible] FORMAT(2(1X,F2[illegible].2))
2027 CONTINUE
READ(17,5052) ITYPE(NOCRUS)
5052 FORMAT(A10)
IF(NOCRUS .EQ. 1)GO TO 5751
SUBSTR(ITYPE(NOCRUS),11,13)=13H + THE ABOVE
GO TO 5750
5751 SUBSTR(ITYPE(NOCRUS),11,1)=1HS
5750 CONTINUE
GO TO 65
97 DO 10 YEAR=1,NOMS
YEAR=([illegible]-1)+YRND
YEARS(YEAR)=YEAR
10 CONTINUE
DO 250 I=1,NOCRUS
DO 1[illegible] YEAR=[illegible]
YR=YEAR-([illegible]-1)
FULSTR(YR)=FUEL(I,YR)
FULINC(YR)=FUEL(I,YR)
BPMSTR(YR)=BPMS(I,YR)
BPMINC(YR)=BPMS(I,YR)
1[illegible] CONTINUE
* FIND MIN. FOR START VALUES WITHIN EACH NOCRUS GP.
* NOTE: NOCRUS=1 REP. 1ST CRAFT; NOCRUS=2 REP. 1ST & 2ND CRAFTS; ETC.
[illegible]=FULSTR(1)
[illegible]=BPMSTR(1)
DO 3[illegible]1 J=2,NOMS
IF([illegible] .GT. FULSTR(J))[illegible]=FULSTR(J)
IF(BPMIN .GT. BPMSTR(J))BPMIN=BPMSTR(J)
3[illegible]1 CONTINUE
* FIND MAX. FOR INCREASE
[illegible]=FULINC(1)
[illegible]=BPMINC(1)
DO 3[illegible]2 J=2,NOMS
IF([illegible] .LT. FULINC(J))[illegible]=FULINC(J)
IF([illegible] .LT. BPMINC(J))[illegible]=BPMINC(J)
3[illegible]2 CONTINUE
[illegible]
[illegible]
[illegible]
[illegible]
[illegible] CONTINUE
```

```
* FIND SUPER MAX OF MAX , SUPER MIN OF MIN ACROSS ROCNUS GROUPS
SFMAX=FUELMX(1,NOMS+2)
SRMAX=RMPS(1,NOMS+2)
SFMIN=FUELMN(1,NOMS+1)
SRMIN=RMPS(1,NOMS+1)
DO 308 I=1,MACNUS
SFMAX=AMAX1(SFMAX,FUELMX(I,NOMS+2))
SRMAX=AMAX1(SRMAX,RMPS(I,NOMS+2))
SFMIN=AMIN1(SFMIN,FUELMN(I,NOMS+1))
SRMIN=AMIN1(SRMIN,RMPS(I,NOMS+1))
308 CONTINUE
* FIND ROUND WHOLE NUMBER IN APPROPRIATE UNITS FOR STEP, & MAX & MIN
* E.G., FYRANG=2500
FYRANG=SFMAX-SFMIN
RYRANG=SRMAX-SRMIN
* E.G., ALOG(FYRANG)=X=2.5, THEN AINT(X)=3.0,& FYSTEP=1000
FYSTEP=10.**AINT(ALOG10(FYRANG))
RYSTEP=10.**AINT(ALOG10(RYRANG))
* E.G., THEN FYMAX=3000
FYMAX=FYSTEP*(1.0+AINT(FYRANG/FYSTEP))
RYMAX=RYSTEP*(1.0+AINT(RYRANG/RYSTEP))
FYMIN=FYSTEP*AINT(SFMIN/FYSTEP)
RYMIN=RYSTEP*AINT(SRMIN/RYSTEP)
YRMAX=AINT(YEARS(NOMS))
YRMIN=AINT(YEARS(1))
* FOLLOW. COMPUTE IDENTIFIES LOC. FOR START OF WORD
CALL NOBRDR(1)
CALL PAGE(12.0,9.0,1.0)
CALL INTAXS
CALL GOTHIC
CALL MASALF('L/CSTD')
CALL MIXALF('STANDARD')
CALL YTICKS(5)
CALL TITLE(1H ,1,'YEARS',100,'FUEL NUMBER: BARRELS$',100,11.0,6.5)
CALL HEADIN('(F)ORECAST (U.S. F)LEET (F)UEL (U)SAGE (D)ISTRIBUTIONS',-100,3,2)
CALL SIMPLX
CALL MASALF('STANDARD')
CALL HEADIN('AGGREGATED ACROSS PARKS$',100,2,2)
CALL YAXANG(0.0)
CALL GRAF(YRMIN,5.0,YRMAX,FYMIN,FYSTEP,FYMAX)
X1=1.5
Y1=5.5
LMAX=LINEST(ITITLE,160,23)
DO 11 I=1,MACNUS
DO 12 YR=1,NOMS
FORM(YR)=FUELMN(I,YR)
12 CONTINUE
CALL RESET(1)
CALL CURVE(YEARS,FORM,NOMS,1)
* FOLLOW. COMPUTE IDENTIFIES LOC. FOR START OF WORD
IL0C=(I-1)*12/...+1
ICTYP=ITYP(I)
CALL LINES(ITYP,ITITLE,1)
11 CONTINUE
```

```
      CALL LEGEND(ITITLE,NOCHVS,X1,Y1)
      CALL ENDPL(1)
      CALL DONEPL
      STOP
      END
```

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APPENDIX B-4

ALTERNATIVE INPUT DATA: BETDA4
(existing aircraft types only)

```
$INPUT1
 EN=2.0, MACH=0.8,
  T=45000.,
   WACS=2950., WAERO=3890., WBODY=36320.,
  WELCAD=2520., WEMP=8160., WENACC=1280., WENGS=23110.,
  WFUSYS=690., WFUTOT=48630.,                  WGROSS=265100., WFYCAD=3770.,
 WINST=670., WLG=15570., WNACEL=11290., WPACCO=19370., WPOWER=2060.,
               WWING=40730., WPAYL=45730.,
  WHANDL=100.0, WANTIC=500.0, WAVION=2120.0, WTHEVS=6990.0,
$END
$INPUT2
 ABI=0.1, AGEOI=0.1, AGEPI=0.1, CFACS=2.7, CFAERO=0.65, CFBODY=0.70,
                          CFELCD=L.80, CFEMP=1.9, CFENAC=0.40,
              CFHYCD=0.55, CFINST=0.70, CFLG=0.70, CFPACC=3.19, CFPOW=3.2,
              CFWING=0.9, CONFIG=1.0, CIJI=1.0, ENSPAO=0.4, FASPAN=.40,
 FACI=0.9, FEE=0.00, FTOI=0.10, FVSPAR=0.2, GTSPAR=0.10, ICONFG=6,
 IDATA=1, IPOWER=2, IPROD=1,
 IOPS=0, NCREW=3.0, NDATA=5, NFV=5.0, NG=1.0, NOENG=150.0,
NOENG1=500.0, NOYRS=0.75, NOYRS1=1.0,
NV=867.0, KVEN=1.0,5.0,100.0,300.0,600.0,
 PDTJI=0.10, RATE=11., RE=17.0, RT=15.0, TOOLC=1.0,
 XFASSY=0.05, XNEW=0.20,
  LEARNP=88.16, LEARN=81.85, LEARNA=81.85,
 CFFUSY=0.10,
$END
  REDUCED ENERGY PROP-FAN (767-767)
$IN
      YEAR=1965., WE=165570., FEE=0.00, NVNF=872. , IAINPL=3,
    API=0.96, IENGS=2, PN=171., EN=2., T=42420.,
   WENGS=20000.,
$END
2222222222
7AP
7.                1.
2AP
LONG       RANGE
6.0        6.0        6.0        6.0        6.0        6.0        6.0        6.0
6.0        6.0        6.0        6.0        6.0        6.0        6.0        6.0
6.0        6.0        6.0        6.0        6.0        6.0        6.0        6.0
6.0        6.0        6.0        6.0        6.0        6.0        6.0        6.0
.60        .60        .60        .60        .60        .60        .60        .60
.60        .60        .60        .60        .60        .60        .60        .60
.60        .60        .60        .60        .60        .60        .60        .60
.60        .60        .60        .60        .60        .60        .60        .60
    3
WENGMATF   1560.      150.1      .1533      405.       2755.      16.          168
        1.         3.         4.         6.         11.        10.        8.         9.
        8.         0.         0.         0.         0.         0.         1.         0.
0.         0.         0.         0.         3.         0.         0.         0.
0.         0.         0.         0.         0.         0.         0.         0.
WENGMATF   1969.      357.0      .1301      456.       3511.      16.          637
        3.         0.         1.         0.         0.         0.         2.         42.
        16.        2.         5.         5.         3.         7.         5.         6.
0.         0.         0.         0.         0.         0.         0.         0.
```

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```
55.    0.          0.       0.       0.       0.       0.       0.       0.
56.    3ENGWATF    1971.    246.2    .1267    419.     2950.    16.      207
57.            0.       0.       0.       0.       0.       0.       0.       0.
58.            3.       11.      11.      9.       6.       1.       1.       4.
59.    0.          0.       0.       0.       0.       0.       0.       0.
60.    0.          0.       0.       0.       0.       0.       0.       0.
61.        9
62.        0
63.    SHORT       RANGE
64.    6.0         6.0      6.0      6.0      6.0      6.0      6.0      6.0
65.    6.0         6.0      6.0      6.0      6.0      6.0      6.0      6.0
66.    6.0         6.0      6.0      6.0      6.0      6.0      6.0      6.0
67.    6.0         6.0      6.0      6.0      6.0      6.0      6.0      6.0
68.    .60         .60      .60      .60      .60      .60      .60      .60
69.    .60         .60      .60      .60      .60      .60      .60      .60
70.    .60         .60      .60      .60      .60      .60      .60      .60
71.    .60         .60      .60      .60      .60      .60      .60      .60
72.        5
73.    4ENGWATF    1960.    150.1    .1914    405.     2759.    16.      087
74.            1.       4.       5.       7.       15.      13.      10.      1.
75.            0.       0.       0.       0.       0.       0.       1.       1.
76.    0.          0.       0.       0.       0.       0.       0.       0.
77.    0.          0.       0.       0.       0.       0.       0.       0.
78.    3ENGWATF    1963.    117.9    .1836    359.     2752.    16.      549
79.            5.       42.      37.      66.      66.      101.     76.      25.
80.            6.       28.      56.      35.      46.      40.      49.      97.
81.    0.          0.       0.       0.       0.       0.       0.       0.
82.    0.          0.       0.       0.       0.       0.       0.       0.
83.    2ENGWATF    1965.    90.5     .2127    312.     2448.    16.      234
84.            0.       0.       6.       21.      31.      143.     109.     16.
85.            13.      16.      29.      27.      41.      27.      29.      47.
86.    0.          0.       0.       0.       0.       0.       0.       0.
87.    0.          0.       0.       0.       0.       0.       0.       0.
88.    3ENGWATF    1971.    246.2    .1373    419.     2950.    16.      115
89.            0.       0.       0.       0.       0.       0.       0.       0.
90.            4.       17.      17.      14.      10.      2.       2.       6.
91.    0.          0.       0.       0.       0.       0.       0.       0.
92.    0.          0.       0.       0.       0.       0.       0.       0.
93.    2ENGWATF    1977.    240.0    .1259    360.     2757.0   16.      015
94.            0.       0.       0.       0.       0.       0.       0.       0.
95.            0.       0.       0.       0.       0.       0.       5.       3.
96.    0.          0.       0.       0.       0.       0.       0.       0.
97.    0.          0.       0.       0.       0.       0.       0.       0.
98.        0
99.        0
100.   MEDIUM      RANGE
101.   6.0         6.0      6.0      6.0      6.0      6.0      6.0      6.0
102.   6.0         6.0      6.0      6.0      6.0      6.0      6.0      6.0
103.   6.0         6.0      6.0      6.0      6.0      6.0      6.0      6.0
104.   6.0         6.0      6.0      6.0      6.0      6.0      6.0      6.0
105.   .60         .60      .60      .60      .60      .60      .60      .60
106.   .60         .60      .60      .60      .60      .60      .60      .60
107.   .60         .60      .60      .60      .60      .60      .60      .60
108.   .60         .60      .60      .60      .60      .60      .60
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109.        4
110.      4ENGWATF  1960.    150.1    .1530    405.     2759.    16.           280
111.             2.       5.       3.      11.      22.      19.      15.         1.
112.             0.       0.       0.       0.       0.       0.       2.         1.
113.      0.       0.       0.       0.       0.       0.       0.       0.
114.      0.       0.       0.       0.       0.       0.       0.       0.
115.      3ENGWATF  1963.    117.9    .1547    359.     2752.    16.           198
116.             1.     -11.       6.      11.      11.      18.      13.         4.
117.             1.       3.       9.       6.       8.       7.       9.        17.
118.      0.       0.       0.       0.       0.       0.       0.       0.
119.      0.       0.       0.       0.       0.       0.       0.       0.
120.      4ENGWATF  1969.    357.4    .1269    456.     3511.    16.           135
121.             0.       0.       0.       0.       0.       0.       0.        12.
122.             5.       0.       1.       1.       1.       2.       2.         2.
123.      0.       0.       0.       0.       0.       0.       0.       0.
124.      0.       0.       0.       0.       0.       0.       0.       0.
125.      3ENGWATF  1971.    246.2    .1236    419.     2950.    16.           308
126.             0.       0.       0.       0.       0.       0.       0.         0.
127.             6.      27.      26.      21.      15.       3.       3.        10.
128.      0.       0.       0.       0.       0.       0.       0.       0.
129.      0.       0.       0.       0.       0.       0.       0.       0.
130.      0
131.        0
```

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ALTERNATIVE INPUT DATA: BETDA7

(two new in first, one new in other market)

```
$INPUT1
 EN=2.0, MACH=0.8,
  T=45000.,
   WACS=2950., WAERO=3099., WBODY=36320.,
  WFLCAD=2520., WENP=8160., WENACC=1280., WEAGS=20110.,
  WFUSYS=603., WFUTOT=48630.,                    WGROSS=269100., WMYCAD=3770.,
 WINST=670., WLG=15570., WNACEL=11290., WPACCO=14370., WPOWER=2060.,
             WWING=40730., WPAYL=45730.,
  WMANUM=100.0, WANTIC=500.0, WAVION=2120.0, WTMEVS=6990.0,
$END
$INPUT2
 ADI=0.1, AGEO1=0.1, AGEPI=0.1, CFACS=2.7, CFAERO=0.65, CFBCDY=0.70,
                           CFELCD=0.80, CFEMP=1.9, CFENAC=0.40,
             CFMYCD=0.55, CFINST=1.70, CFLG=0.70, CFPACC=3.10, CFPOW=3.2,
             CFWING=0.9, CONFIG=1.0, CTJI=1.0, EASPAO=0.4, EASPAN=.40,
 FACI=0.9, FEE=0.00, FIOI=0.10, FUSPAR=0.2, GTSPAN=0.10, ICONFG=0,
 IDATA=1, IPOWER=2, IPROD=1,
 IOPS=0, NCREW=3.0, NDATA=5, NFV=5.0, NG=1.0, NOENG=150.0,
POFNG1=500.0, NOYRS=0.75, NOYRS1=1.0,
NV=867.0, NVEN=1.0,5.0,100.0,300.0,600.0,
 PDTJI=0.10, RATE=11., RE=17.0, RT=15.0, TOCLC=1.0,
 XFASSV=0.95, XNEW=0.29,
  LEARNP=88.10, LEARN=81.65, LEARNA=81.65,
 CFFUSV=0.10,
$END
  REDUCED ENERGY PROP-FAN (767-762)
$IN
        YEAR=1985., WE=165570., FEF=0.30, NUNF=872. , IAIRPL=3,
     API=0.06, IENGS=2, PN=171., EN=2., T=42420.,
    WENGS=20000.,
$END
2222222222
ZAP
7.                   1.
ZAP
LONG      RANGE
6.0       6.0       6.0       6.0       6.0       6.0       6.0       6.0
6.0       6.0       6.0       6.0       6.0       6.0       6.0       6.0
6.0       6.0       6.0       6.0       6.0       6.0       6.0       6.0
6.0       6.0       6.0       6.0       6.0       6.0       6.0       6.0
.60       .60       .60       .60       .60       .60       .60       .60
.60       .60       .60       .60       .60       .60       .60       .60
.60       .60       .60       .60       .60       .60       .60       .60
.60       .60       .60       .60       .60       .60       .60       .60
    7
NENGNWIF  1960.     150.1     .1533     405.      2759.     14.           131
         1.        3.        4.        0.        11.       10.       8.        0.
         0.        0.        0.        0.        0.        0.        1.        0.
0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.
NENGNWIF  1969.     357.4     .1101     456.      3511.     14.           593
         9.        0.        0.        .         0.        0.        2.        42.
         16.       2.        5.        5.        3.        7.        5.        5.
0.        0.        0.        0.        0.        0.        0.        0.
```

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```
55.     0.        0.       0.       0.       0.      0.       0.       0.
56.     3ENGWATF  1971.    246.2    .1267    419.    2950.    16.         144
57.              0.       0.       0.       1.       C.      0.       0.       C.
58.              3.       11.      11.      9.       4.      1.       1.       4.
59.     0.        0.       0.       0.       0.      0.       0.       0.
60.     0.        0.       0.       0.       0.      0.       0.       0.
61.         0
62.         2
63.     3EWA777   1987.    210.0    .134     450.    2484.0   16.         030
63.01   2FWA767   1984.  • 200.0    .121     360.    2920.0   16.         080
64.     SHORT     RANGE
65.     6.0       6.0      6.0      6.0      6.0     6.0      6.0      6.0
66.     6.0       6.0      6.0      6.0      6.C     6.0      6.0      6.0
67.     6.0       6.0      6.0      6.0      6.0     6.0      6.0      6.0
68.     6.0       6.0      6.0      6.0      6.C     6.0      6.0      6.0
69.     .60       .60      .60      .60      .60     .60      .60      .60
70.     .60       .60      .60      .60      .60     .60      .60      .60
71.     .60       .60      .60      .60      .60     .60      .60      .60
72.     .60       .60      .60      .60      .60     .60      .60      .60
73.         5
74.     4ENGWATF  1960.    150.1    .1914    405.    2759.    16.         081
75.              1.       4.       5.       1.      15.      13.      10.      1.
76.              0.       0.       0.       0.      3.       0.       1.       1.
77.     0.        0.       0.       0.       0.      0.       0.       0.
78.     0.        0.       0.       0.       0.      0.       0.       0.
79.     3ENGWATF  1963.    117.9    .1836    359.    2752.    16.         583
80.              5.       42.      37.      66.     64.      101.     76.      25.
81.              6.       20.      52.      35.     46.      80.      49.      97.
82.     0.        0.       0.       0.       C.      0.       0.       0.
83.     0.        0.       0.       0.       0.      0.       0.       0.
84.     2ENGWATF  1965.    90.5     .2127    312.    2448.    16.         226
85.              0.       0.       6.       21.     31.      143.     139.     16.
86.             13.       16.      29.      27.     41.      27.      29.      47.
87.     0.        0.       0.       0.       0.      0.       0.       0.
88.     0.        0.       0.       0.       C.      0.       0.       0.
89.     3ENGWATF  1971.    246.2    .1373    419.    2950.    16.         109
90.              0.       0.       0.       0.      C.       0.       0.       0.
91.              4.       17.      17.      14.     13.      2.       2.       6.
92.     0.        0.       0.       0.       0.      0.       0.       0.
93.     0.        0.       C.       C.       C.      0.       0.       0.
94.     2ENGWATF  1977.    240.0    .1259    360.    2752.0   16.         009
95.              0.       0.       0.       0.      0.       0.       0.       0.
96.              0.       0.       0.       0.      C.       0.       4.       3.
97.     0.        C.       0.       0.       0.      0.       0.       0.
98.     0.        0.       0.       C.       C.      C.       C.       C.
99.         9
100.        1
101.    2ENW757   1982.    150.0    .147     300.    1987.0   16.         07C
102.    MEDIUM    RANGE
103.    6.0       6.0      6.0      6.0      6.0     6.0      6.0      6.C
104.    6.0       6.0      6.0      6.0      6.0     6.0      6.0      6.0
105.    6.0       6.C      6.0      6.0      6.0     6.0      6.0      6.0
106.    6.0       6.0      6.0      6.0      6.0     6.0      6.0      6.0
107.    .60       .60      .60      .60      .60     .60      .60      .60
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108.	.60		.60		.60		.60		.60		.60		.60		.60		
109.	.60		.60		.60		.60		.60		.60		.60		.60		
110.	.60		.6C		.60		.60		.6C		.60		.60				
111.	4																
112.	4ENGWATF		1960.		150.1		.1530		405.		2759.		16.			271	
113.		2.		5.		7.		11.		22.		19.		15.			1.
114.		0.		0.		0.		0.		0.		0.		2.			1.
115.	0.		0.		0.		0.		C.		0.		0.		0.		
116.	0.		0.		0.		0.		0.		0.		0.		0.		
117.	3FNGNPTF		1563.		117.9		.1547		359.		2757.		16.			191	
118.		1.		11.		6.		11.		11.		18.		13.			4.
119.		1.		3.		9.		6.		8.		7.		9.			17.
120.	0.		0.		G.		0.		0.		0.		0.		0.		
121.	0.		0.		0.		0.		0.		0.		0.		0.		
122.	4FNGW*TF		1969.		357.4		.1269		456.		3511.		16.			128	
123.		0.		0.		0.		0.		0.		0.		0.			17.
124.		5.		0.		1.		1.		1.		2.		2.			2.
125.	0.		0.		0.		0.		C.		0.		0.		0.		
126.	0.		0.		0.		0.		0.		0.		0.		0.		
127.	3FNGWATF		1571.		246.2		.1236		419.		295C.		16.			30C	
128.		0.		0.		0.		0.		0.		0.		0.			0.
129.		6.		77.		26.		21.		15.		3.		3.			10.
130.	0.		0.		0.		0.		0.		0.		0.		0.		
131.	0.		0.		0.		0.		C.		0.		0.		0.		
132.	0																
133.	1																
134.	2EWB767		1980.		204.0		.121		360.		2920.3		16.			030	

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ALTERNATIVE INPUT DATA: SETDB1

```
$INPUT1
 EN=2.0,  MACH=0.8,
  T=45000.,
   WACS=2950.,  WAERO=3890.,  WBODY=36320.,
  WELCAD=2520.,  WEMP=8160.,  WENACC=1280.,  WENGS=20110.,
  WFUSYS=440.,  WFUTOT=48630.,                    WGROSS=269100.,  WHYCA
D=3770.,
 WINST=670.,  WLG=15570.,  WNACEL=11290.,  WPACCD=19370.,  WPOWER=20
60.,
                  WWING=40730.,  WPAYL=45730.,
  WHANDL=100.0,  WANTIC=500.0,  WAVION=2120.0,  WTREVS=6990.0,
$END
$INPUT2
 ADI=0.1, AGEDI=0.1,  AGEPI=0.1,  CFACS=2.7,  CFAERO=0.65,  CFBODY=0
.70,
                          CFELCD=0.80, CFEMP=1.9,  CFENAC=0.40,
               CFHYCD=0.55,  CFINST=0.70,  CFLG=0.70,  CFPACC=3.10,
CFPOW=3.2,
               CFWING=0.9,  CONFIG=1.0,  CTJI=1.0,  ENGPAO=0.4,  ENGP
AR=.40,
 FACI=0.0,  FEE=0.00,  FTOI=0.10,  FVSPAR=0.2,  GTSPAR=0.10,  ICONFG
=6,
 IDATA=1,  IPOWER=2,  IPROD=1,
 IOPS=0,  NCREW=3.0,  NDATA=5,  NFV=5.0,  NG=1.0,  NOENG=150.0,
NOENG1=500.0,  NOYRS=0.75,  NOYRS1=1.0,
NV=867.0,  NVEH=1.0,5.0,100.0,300.0,600.0,
 PDTJI=0.10,  RATE=11.,  RE=17.0,  RT=15.0,  TOOLC=1.0,
 XFASSY=0.05,  XNEW=0.20,
  LEARNP=88.18,  LEARN=81.85,  LEARNA=81.85,
 CFFUSY=0.10,
$END
  REDUCED ENERGY PROP-FAN (767-762)
$IN
       YEAR=1985.,  WE=165570.,  FEE=0.00,  NVHF=872. ,  IAIRPL=3,
     API=0.06,  IENGS=2,  PN=171.,  EN=2.,  T=42420.,
    WENGS=20000.,
$END
ZZZZZZZZZZ
ZAP
7.                 1.
ZAP
LONG       RANGE
6.0        6.0        6.0        6.0        6.0        6.0        6.0
6.0
6.0        6.0        6.0        6.0        6.0        6.0        6.0
6.0
6.0        6.0        6.0        6.0        6.0        6.0        6.0
6.0
6.0        6.0        6.0        6.0        6.0        6.0        6.0
6.0
.64        .64        .64        .64        .64        .64        .64
.64
.64        .64        .64        .64        .64        .64        .64
.64
.64        .64        .64        .64        .64        .64        .64
.64
.64        .64        .64        .64        .64        .64        .64
.64
     6
```

```
 45          6
 46     4ENGNDTF  1960.     152.4     .1914     439.5     2007.8    16.0
 183
 47              5.9     17.7      22.1      35.4      70.9      60.5      48.
7        3.0
 48              1.5      1.5       1.5      0.        0.        1.5       5.
9        3.0
 49              0.0      0.0       0.0      0.0       0.0       0.0       0.
0        0.0
 50              0.0      0.0       0.0      0.0       0.0       0.0       0.
0        0.0
 51     2ENGNDTF  1965.      95.1     .1745     464.4     2581.5    16.0
 016
 52              0.       0.        .2       .6        .9       4.1       3.
1         .5
 53               .4       .5       .8       .8       1.2        .8        .
8        1.3
 54              0.0      0.0       0.0      0.0       0.0       0.0       0.
0        0.0
 55              0.0      0.0       0.0      0.0       0.0       0.0       0.
0        0.0
 56     3ENGNDTF  1963.     120.4     .1634     420.8     2812.9    16.0
 258
 57              2.0     23.7      14.0      25.0      25.0      38.7      28.
9        9.4
 58              2.3      7.5      19.8      13.3      17.4      15.3      18.
9       37.1
 59              0.0      0.0       0.0      0.0       0.0       0.0       0.
0        0.0
 60              0.0      0.0       0.0      0.0       0.0       0.0       0.
0        0.0
 61     2ENGNDTF  1977.     238.0     .1136     409.6     2153.7    16.0
 008
 62              0.       0.        0.       0.        0.        0.        0.
         0.
 63              0.       0.        0.       0.        0.        0.        3.
7        2.2
 64              0.0      0.0       0.0      0.0       0.0       0.0       0.
0        0.0
 65              0.0      0.0       0.0      0.0       0.0       0.0       0.
0        0.0
 66     3ENGNDTF  1971.     244.7     .1251     429.7     2997.3    16.0
 274
 67              0.       0.        0.       0.        0.        0.        0.
         0.
 68              9.3     39.3      38.4      31.4      22.2       4.3       4.
3       14.3
 69              0.0      0.0       0.0      0.0       0.0       0.0       0.
0        0.0
 70              0.0      0.0       0.0      0.0       0.0       0.0       0.
0        0.0
 71     4ENGNDTF  1969.     369.8     .1288     489.4     3434.9    16.0
 264
 72              0.       0.        0.       0.        0.        0.        1.
5       41.8
 73             16.3      1.5       4.6      4.6       3.1       7.0       5.
4        5.4
 74              0.0      0.0       0.0      0.0       0.0       0.0       0.
0        0.0
 75              0.0      0.0       0.0      0.0       0.0       0.0       0.
0        0.0
 76          0
 77          1
 78     2ENB777   1987.     210.0     .1249     500.0     3500.0    16.0
 010
 79     SHORT     RANGE
 80     6.0       6.0       6.0       6.0       6.0       6.0       6.0
6.0
```

```
     6.0
      81     6.0      6.0      6.0      6.0      6.0      6.0      6.0
     6.0
      82     6.0      6.0      6.0      6.0      6.0      6.0      6.0
     6.0
      83     6.0      6.0      6.0      6.0      6.0      6.0      6.0
     6.0
      84     .54      .54      .54      .54      .54      .54      .54
     .54
      85     .58      .58      .58      .58      .58      .58      .58
     .58
      86     .64      .64      .64      .64      .64      .64      .64
     .64
      87     .64      .64      .64      .64      .64      .64      .64
     .64
      88          6
      89     4ENGMBTF 1960.    151.3    .4447    220.6    2013.8   16.0
      043
      90              .8       2.4      3.0      4.8      9.6      8.2      6.
  6          .4
      91              .2       .2       .2       0.       0.       .2
  8          .4
      92              0.0      0.0      0.0      0.0      0.0      0.0      0.
  0         0.0
      93              0.0      0.0      0.0      0.0      0.0      0.0      0.
  0         0.0
      94     4ENGMBTF 1970.    378.6    .3045    183.5    3434.9   14.0
      011
      95              0.       0.       0.       0.       0.       0.       .
  0         1.3
      96              .5       .0       .1       .1       .1       .2       .
  2          .2
      97              0.0      0.0      0.0      0.0      0.0      0.0      0.
  0         0.0
      98              0.0      0.0      0.0      0.0      0.0      0.0      0.
  0         0.0
      99     3ENGMBTF 1971.    271.7    .2480    182.7    2997.3   16.0
      036
     100              0.       0.       0.       0.       0.       0.       0.
            0.
     101              .8       3.4      3.4      2.7      1.9      .4       .
  4         1.2
     102              0.0      0.0      0.0      0.0      0.0      0.0      0.
  0         0.0
     103              0.0      0.0      0.0      0.0      0.0      0.0      0.
  0         0.0
     104     2ENGMBTF 1977.    235.4    .1971    167.8    2113.4   16.0
      002
     105              0.       0.       0.       0.       0.       0.       0.
            0.
     106              0.       0.       0.       0.       0.       0.       .
  5          .3
     107              0.0      0.0      0.0      0.0      0.0      0.0      0.
  0         0.0
     108              0.0      0.0      0.0      0.0      0.0      0.0      0.
  0         0.0
     109     2ENGMBTF 1965.    95.2     .2393    233.6    2581.5   16.0
      503
     110              0.       0.       4.0      13.9     20.6     94.9     72.
  4         10.6
     111              8.6      10.6     19.3     17.9     27.2     17.9     19.
  3         31.2
     112              0.0      0.0      0.0      0.0      0.0      0.0      0.
  0         0.0
     113              0.0      0.0      0.0      0.0      0.0      0.0      0.
  0         0.0
```

```
0          0.0
. 114         3ENMBTF   1963.     123.5     .2627     232.7     2812.9    16.0
    405
  115                   1.5       18.5      10.9      19.5      19.8      30.2      22.
5          7.3
  116                   1.0       5.8       15.5      10.4      13.7      11.9      14.
7         28.9
  117                   0.0       0.0       0.0       0.0       0.0       0.0       0.
0          0.0
  118                   0.0       0.0       0.0       0.0       0.0       0.0       0.
0          0.0
  119           0
  120           1
  121         2ENB787   1984.     150.0     .1264     300.0     1987.0    16.0
    030
  122         MEDIUM    RANGE
  123         6.0       6.0       6.0       6.0       6.0       6.0       6.0
 6.0
  124         6.0       6.0       6.0       6.0       6.0       6.0       6.0
 6.0
  125         6.0       6.0       6.0       6.0       6.0       6.0       6.0
 6.0
  126         6.0       6.0       6.0       6.0       6.0       6.0       6.0
 6.0
  127         .64       .64       .64       .64       .64       .64       .64
 .64
  128         .64       .64       .64       .64       .64       .64       .64
 .64
  129         .64       .64       .64       .64       .64       .64       .64
 .64
  130         .64       .64       .64       .64       .64       .64       .64
  131           6
  132         4ENMBTF   1960.     152.5     .2310     354.3     2009.2    16.0
    083
  133                   2.0       5.9       7.4       11.9      23.8      20.3      16.
3          1.0
  134                   .5        .5        .5        0.        0.        .5        2.
0          1.0
  135                   0.0       0.0       0.0       0.0       0.0       0.0       0.
0          0.0
  136                   0.0       0.0       0.0       0.0       0.0       0.0       0.
0          0.0
  137         4ENMBTF   1969.     374.2     .1634     339.3     3436.9    16.0
    009
  138                   0.        0.        0.        0.        0.        0.        .
1          2.1
  139                   .8        .1        .2        .2        .2        .4        .
3          .3
  140                   0.0       0.0       0.0       0.0       0.0       0.0       0.
0          0.0
  141                   0.0       0.0       0.0       0.0       0.0       0.0       0.
0          0.0
  142         3ENMBTF   1971.     269.5     .1487     331.7     2997.3    16.0
    102
  143                   0.        0.        0.        0.        0.        0.        0.
           0.
  144                   2.5       10.7      10.5      8.5       6.0       1.2       1.
2          3.9
  145                   0.0       0.0       0.0       0.0       0.0       0.0       0.
0          0.0
  146                   0.0       0.0       0.0       0.0       0.0       0.0       0.
0          0.0
  147         2ENMBTF   1965.     95.2      .1887     341.6     2851.5    16.0
    245
  148                   0.        0.        2.4       8.5       12.6      98.2      44.
3          4.5
- 149                   5.3       4.5       11.8      11.0      16.7      11.0      11.
```

```
8    19.1
 150          0.0      0.0      0.0      0.0      0.0      0.0      0.
0    0.0
 151          0.0      0.0      0.0      0.0      0.0      0.0      0.
0    0.0
 152     3ENGMBTF  1963.    122.0     .1836    349.6    2812.9    14.0
  589
 153          2.7     32.6     19.2     34.4     34.4     53.2     39.
8    13.0
 154          3.1     10.3     27.3     18.3     24.2     21.0     25.
9    51.0
 155          0.0      0.0      0.0      0.0      0.0      0.0      0.
0    0.0
 156          0.0      0.0      0.0      0.0      0.0      0.0      0.
0    0.0
 157     2ENGMBTF  1977.    232.7     .1264    316.7    3481.9    16.0
  002
 158          0.       0.       0.       0.       0.       0.       0.
     0.
 159          0.       0.       0.       0.       0.       0.       .
8     .5
 160          0.0      0.0      0.0      0.0      0.0      0.0      0.
0    0.0
 161          0.0      0.0      0.0      0.0      0.0      0.0      0.
0    0.0
 162       0
 163       1
 164     2EMB767   1983.    200.0     .1260    360.0    2920.0    16.0
  030
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